AD-A080 766 HONEYWELL SYSTEMS AND RESEARCH CENTER MINNEAPOLIS MN F/G 17/2
SYSTEM CONTROL FOR THE TRANSITIONAL DCS. APPENDICES.(U)
DEC 78 F C ANNAND, M F BURKE, R K CROWE DCA100-78-C-0017
UNCLASSIFIED TR-2-APP SBIE-AD-E100 327 NL

1 OF 2
AD A
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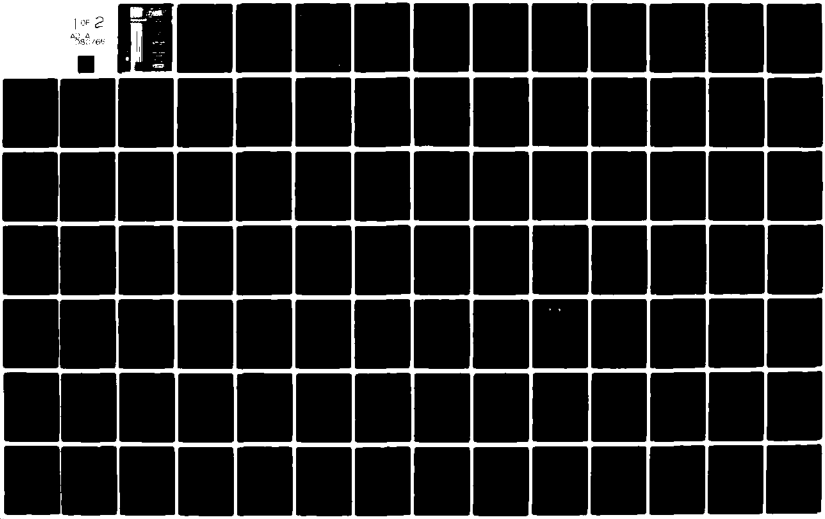

UNCLASSIFIED December 1978

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
Two

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
6 System Control for the Transitional DCS.
[redacted]
Appendices.

5. TYPE OF REPORT & PERIOD COVERED
9 Interim Report,
Jan [redacted]78 — Sep [redacted]79,

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
10 F. C. Annand, M. F. Burke, R. K. Crowe, D. E. Doty, S. S. McClain, ~~R. E. Turner~~

8. CONTRACT OR GRANT NUMBER(s)
15 DCA 100-78-C-0017

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Honeywell System and Research Center
Aerospace and Defense Group
2700 Ridgway Parkway, Minneapolis, NM 55413

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
Defense Communications Agency - DCEC-R310
1860 Wiehle Avenue
Reston, VA 22090

12. REPORT DATE
11 Dec[redacted]78

13. NUMBER OF PAGES
180

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
12 167

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for Public Release - Distribution Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
14 TR-2-APP

18. SUPPLEMENTARY NOTES
18 SBIE 19 AD-E100 327

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Mid 1980 DCS
Transmission subsystems
Common User Networks
Status and performance parameters
Data collection and telemetry controls
System Control

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Appendix A to Report 2 presents the subsystem's characteristics of the anticipated DCS of the mid 1980 affecting management and control capabilities. Appendix B details the software sizing assessment for implementing the system control requirements in report number 2. Appendix C reviews selected scenarios extracted from report 1. In all, a total of four reports were produced under two tasks.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

A 080 801

SYSTEM CONTROL FOR
THE TRANSITIONAL DCS

TECHNICAL REPORT NUMBER 2

APPENDICES

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December 1978

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CONTENTS

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APPENDIX A

CHARACTERIZATION OF SUBSYSTEMS

A.0 INTRODUCTION

This appendix provides overviews of the subsystems which are critical elements of the Transitional DCS. These are:

- AUTOVON/AUTOSEVOCOM II based on the TTC-39 and SB-3865
- AUTODIN II
- The DSCS Control Segment
- The ATEC system defined by the ATEC 10000 specification

The items highlighted are:

- The general functional characteristics of the subsystems
- The data collection and telemetry capabilities of the subsystems
- The control capabilities of the subsystems
- The ability of the subsystems to take on additional tasks as may be required for System Control

A.1 CHARACTERIZATION OF AUTOVON

The AUTOVON system in the time frame of this study is an integration of the service of the current AUTOVON and AUTOSEVOCOM services. The overseas portion of the network is based on the deployment of the AN/TTC-39 circuit switch. This is a hybrid analog/digital switch providing the following services:

- o Non-secure analog telephone service.
- o Non-secure 16 Kb/s digital telephone service.
- o Secure 16 Kb/s digital telephone service with automatic key distribution and end to end security.
- o Analog circuits to support current inventory 50 Kb/sec and 9.6 Kb/sec secure digital communications.

In the deployment model for this study, there are nine TTC-39s in Europe. They are located where each of the current AUTOVON switches, except Mt. Pateras, are now located. The details of the deployment model are contained in the first technical report.

Most users of the AUTOVON system will not be directly connected to the TTC-39 switches, but will be concentrated behind PABXs. Analog subscribers will be concentrated behind current inventory equipment. Digital subscribers will be concentrated behind SB-3865 switchboards from the unit level switch family.

A.1.1 The AN/TTC-39

The TTC-39 is a computer controlled circuit switch for hybrid analog/digital networks. The switch contains two separate switch matrices, which can be cross connected via intermatrix units. A four stage space division matrix built with SCR cross points is used for all analog switching. Digital switching is performed in a redundant memory nonblocking time division matrix. Each matrix is modular in construction with 150 terminations per module. In the expandable version of the switch, any combination of switch modules can be installed up to a total of five modules. A five module configuration is called a 600 line switch, although it actually has a capacity greater than 600 lines. Up to five basic switches can be connected together to form larger switches from 900 to 3000 line (nominal) switches. The normal fixed plant installation is a 2400 line unit.

The analog switch matrix is capable of handling voice and wide-band channels. The digital switch matrix operates on 32Kb/sec bit streams in the tactical version and 16Kb/sec in the strategic version. The normal digitized voice signal is continually variable slope delta (CVSD) modulated. The intermatrix units between the analog and digital switch matrices are CVSD CODECs.

Trunk Characteristics

The TTC-39 connects to a wide variety of analog and digital trunks.

Digital trunk groups are multiplexed internally in the TTC-39 into any of the TRI TAC group formats. Details of the TRI TAC group formats are found in the ICD-003. The simplest TRI TAC group format is the type 1 format. It consists of m bit interleaved channels, with $m = 8$ or 9×2^n and $0 \leq n \leq 4$ or $m = 48$. The first channel in the group is used for overhead and framing and the rest are traffic channels. The overhead channel carries the framing pattern, an 8Kb/sec signalling channel, and three 2Kb/sec system control telemetry channels. Type 2 group formats are not used in the TTC-39. Type 3 formats are formed by bit interleaving type 1 groups, possibly of different sizes. Because of the various different size groups which can be combined, there are five different type 3 formats.

The digital signal actually appearing at the signal entrance panel of the TTC-39 is called a digital transmission group and is of type 1 or 3. It may contain multiple trunk groups and also loop groups. The switch has a capability for a maximum of four transmission groups per 150 termination module.

A large number of analog trunk interfaces exist for the TTC-39. For this study the most important ones are the AUTOVON interfaces. The TTC-39 can act as an AUTOVON tandem switch using 2600 HZ SF supervision and MF 2/6 signalling in either the confirmation or non confirmation (wink start) mode. Early cut through and no early cut through routing capabilities are provided. DCAC 310-V185-7 provides details c. these signalling techniques. Trunk time-out in case of an all RSJ busy or glare condition is specified at two seconds when operating in these modes.

The TTC-39 can also act as an AUTOVON PBX using DTMF signalling outward and SF signal dial pulse signalling from the AUTOVON switch.

Many other analog trunk interfaces exist. Any TTC-39 installations would not have all these interfaces, but only the ones necessary for its installed configuration. These interfaces are on plug in printed circuit cards and can be changed as necessary.

There are no direct PCM trunk interfaces. All analog trunks appear individually at the signal entrance panel and are externally multiplexed.

When two TTC-39 switches are connected with both analog and digital trunks, all trunk signalling can be performed over the digital common signalling channel at the option of the switch supervisor. The supervisor has the capability to change from individual to collective signalling and vice versa, presumably with verbal coordination at the distant end. There is no capability currently in the switch to make this change from system control.

<u>Routing</u>

The routing strategy in the TTC-39 is originating office control with spill. For calls within an area code, the TTC-39 has a primary route and optionally up to five alternate routes. For calls to distant areas, in addition to the six normal routes, the TTC-39 may have a "preferred" route and an "alternate area" route. The preferred and alternate area routes would be searched for an idle trunk before searching the primary route if they exist.

The routing policy used at originating or gateway switches is as follows:

- The trunk group cluster corresponding to the first entry in the routing table is examined to see if a trunk with the proper mode and security is available.
- If no such trunk exists and the switch is the control switch for the call, the trunk group clusters corresponding to the remaining entries in the routing table are searched for an available trunk with the proper mode and security.
- When all alternatives have been searched and no trunk is found, the search is repeated for a preemptible trunk with the proper mode and security.

- If no preemptible trunk is found with the proper mode and security, the search is repeated for an available trunk which could be used with mode or security conversion.
- If no incompatible trunk is available, the search is repeated for a preemptible trunk which could be used with mode or security conversion.

At tandem switches, the call is output over the same type trunk as it arrived over or is blocked. These routing procedures are different from those used in TRI TAC, which performs mode conversion before preemption.

Conferencing

The TTC-39 has the capability for network wide conferencing, either preprogrammed, progressive, or broadcast. In any case, where the conference spans multiple switches, only one trunk is used between switches with conference bridges used in each switch.

Hardware Description

The TTC-39 hardware is divided into the following equipment groups:

- Central Processor
- Operations and Maintenance
- Switch Controller
- Space Division Switching Group
- Time Division Switching Group
- Power

- CESE
- TENLEY
- Ancillary

The central processor group consists of a redundant (hot standby) computer system with keyboard display, mag tape, etc. This equipment group makes all decisions about actions to be taken in the switch and monitors the internal status of the switch. The processor does not actually control any of the switching equipments, but rather passes data to the switch controller group.

The switch controller group consists of a CPU controller and controllers for the various equipment types in the switch. The CPU controller coordinates requests for I/O between the CPU and the various equipments, and provides temporary buffer storage for data moving between equipments and the CPU.

The space division switching group consists of the space division matrix as well as its various signalling and supervision equipment, adapters, and the IMU's (CVSD CODECs).

The time division switching group consists of the time division matrix, the digital scanner, multiplexing and demultiplexing equipment, group and loop modems, the trunk signalling buffer, and miscellaneous other equipments.

In both switching groups, any common equipment is connected directly to the main switch matrix.

The space division switching group consists of the space division matrix (SDMX), analog line terminating units, tone and DC scanners, and analog common equipment. There are three types of line terminating units as follows:

- o Normal Wideband
- o Extended Wideband
- o 2 Wire

The normal wide band unit terminates lines (either trunks or loops) which have a four wire 600 ohm interface, either tone or DC supervision, and MF, DTMF, or dial pulse signalling. The extended wideband unit interfaces four wire 135 ohm lines without supervision or signalling capabilities. It is used to interface the KY-3 adapter to the SDMX. The two wire unit interfaces tone or DC supervised lines using DTMF or signal pulse signalling. Common equipment consists of the following equipments:

- o DTMF receivers
- o DTMF senders
- o MF receivers
- o MF senders
- o 20 HZ ringers
- o Conference bridges
- o IMU's

These devices make direct appearances on the SDMX. Also part of the space division switching group is a set of special circuits to interface various line types to one of the line terminating units.

The time division switching group consists of the following equipments:

- o The time division matrix
- o Digital scanner
- o Digital digit receivers
- o Multiplexers and demultiplexers
- o Group and loop modems
- o Trunk signalling buffers
- o Essential users bypass

The time division matrix is a strictly non blocking single stage switch matrix using time slot interchange for the switching function. Redundant memory techniques are used to reduce the logic speed in the switch. The matrix operates on 3-64 channel groups formed internal to the switch.

The digital scanner sequentially samples each channel in the internal switch group to detect the presence of supervisory signals. These supervisory signals are in the form of permutable codewords representing sieze, release, recall, etc., which come from DSVT or DNVT instruments. Any analog loops terminated on the time division matrix are connected through to the analog scanner and receivers for signalling and supervision.

The multiplexers in the time division matrix are the group multiplexer, the loop multiplexer, and the switch multiplexer. The group multiplexer is a plug progammable device which accepts four groups of any size between 8 and 144 channels and demultiplexes them into 144 individual channels. The switch multiplexer combines the 144 channels together with other equipment channels to form the three 64 channel switch groups. If individual loops are terminated on the switch, they are first combined into a single group which is an input to the group multiplexer. Loops and groups also have diphase modems associated with them.

The trunk signalling buffer provides coding and temporary data storage for trunk signalling messages. It performs detection/insertion of control characters, provides 64 characters of storage in each direction, and notifies the processor when it receives a signalling message or has room in its transmit buffer. It performs quasi cyclic half rate coding and decoding for error protection. In addition to the trunk signalling functions, the trunk signalling buffer multiplexes the system control message data onto the overhead subchannel of the transmission group.

The essential users bypass is a manual control for the connection control memory independent of the switch processor. If both processors are in the off line mode, the essential user bypass can be used to establish a set of connections through the time division switch.

Software Description

The software of the TTC-39 is constructed of functional modules operating at multiple levels of priority. The priority levels of the various modules and their associated data tables are shown in Figure A-1. Every 100 msec., the program flow is started at the top of the figure. As the processing is completed at each level, the processing proceeds to the next level down. The functions of the program modules are as follows:

- The Executive Scheduler schedules the major programs, services interrupts, and initiates program activity.

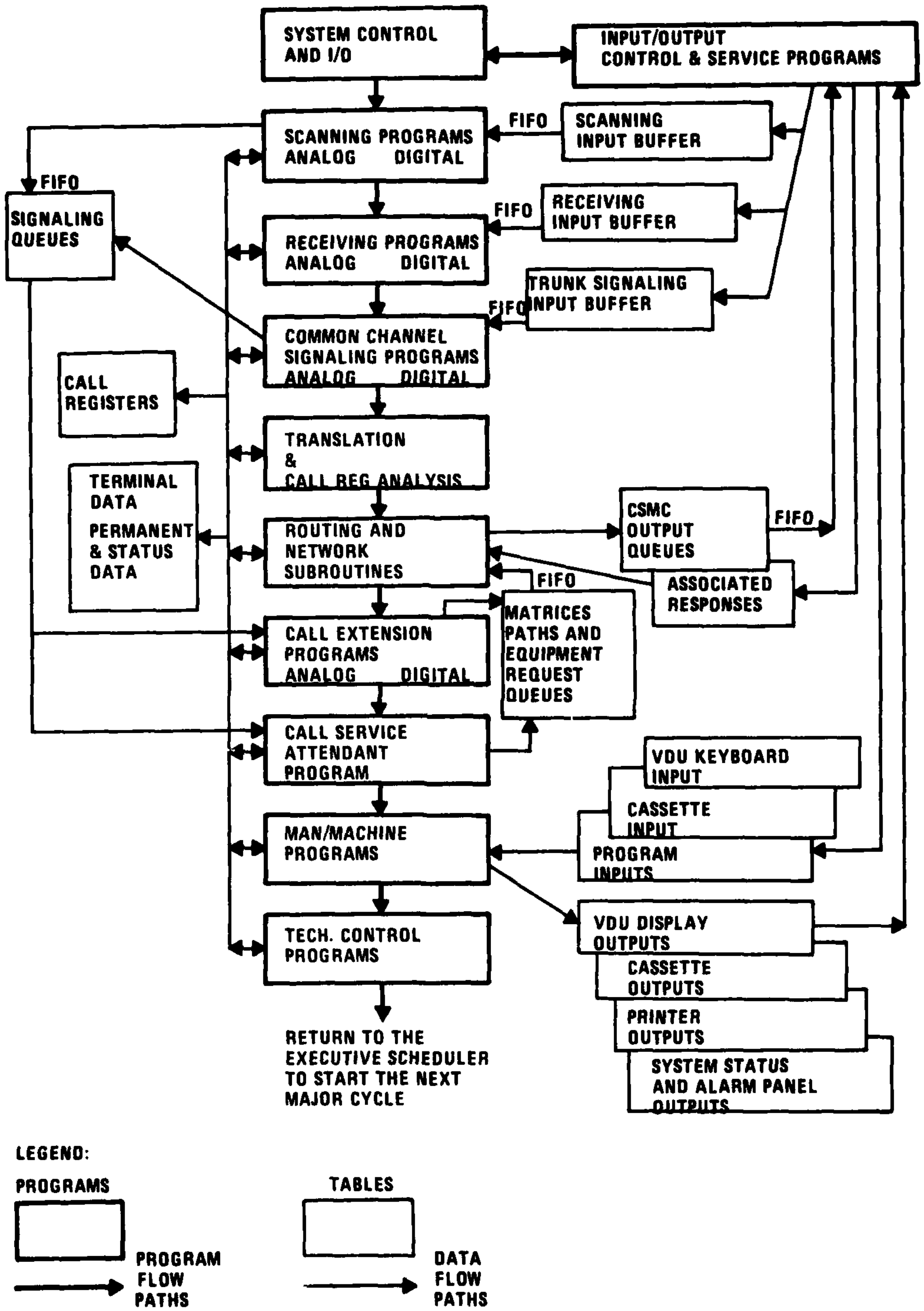


Figure A-1. General Program and Data Flow for the Circuit Switch Operational Program

- The I/O programs take care of real time hardware generated inputs, real time hardware outputs, and the man/machine I/O interface.
- The Scanning programs process scanner hardware generated inputs.
- The Receiving programs process the real time receiver hardware generated inputs.
- Call Register Analysis-Translation programs process access codes and telephone numbers.
- The Routing-Network Subroutines programs select, reserve and bookkeep the circuit switch matrix paths, associated pooled equipments and also maintain a history of connections and equipments that are in use.
- The Call Extension program provides for outgoing signalling and supervision sequences.
- The Call Service Attendant Position program provides for operator function processing.
- The Man/Machine section contains the processing units for the Operation and Maintenance Subsystem (OMS) functions associated with the VDU keyboard/printer, cassette, and system alarm panel.
- The Technical Control section consists of the System Exercise/Diagnostic Unit and the System Performance Reporting Unit.
- The System Exercise/Diagnostic Unit is responsible for subscriber/trunk continuity and transmission quality testing; test and measurement of the performance of switch elements including the matrix,

interfaces and common equipment; and fault isolation to the LRU and reconfiguration in the event of a malfunction. Manually initiated and automatic features are provided.

- o The Performance Reporting Unit is responsible for collecting and reporting traffic status and equipment performance and availability status.

- o The Inter-Computer Communication section is responsible for transferring data between the active and standby processors. This function ensures that an orderly transfer of control to the standby processor can occur when required.

System Control Functions

The TTC-39 is designed to be a manned switch interfacing with the automated Tactical Communications Control Facility (TCCF). It therefore has capabilities for both manual and automatic system control. The switch supervisor has the option of allowing the switch to respond automatically to TCCF directives or to cause directives to be displayed on the supervisor's display. In the latter mode, the supervisor can comply with the directive or reject it.

Technical Control Functions--The switch supervisor is provided three major control equipments for controlling the switch as follows:

- o The control and alarm panel (CAP)

- o The keyboard display (KD)

- o The page printer

The CAP provides the following functions:

- Initiation of call processing
- Manual configuration control of redundant equipment
- Equipment status and alarm indication
- Traffic load restriction status indication

The KD is the supervisor's primary means of controlling the system. The supervisor can monitor or change any item in the switch data base via the KD including the following:

- Subscriber classmarks
- Trunk group assignments
- Routing tables
- System time outs and thresholds

The supervisor can also initiate switch self test routines from the KD.

The page printer is used primarily as a journaling device. All equipment failure messages from the switch and all directives from the TCCF are printed on the page printer.

The switch supervisor is also provided with patch panels associated with the switch modules. Each space division switch module is provided with a patch panel capable of reassigning loops, trunks and common equipment from their normal switch termination to any other termination. The patch panel can also be used for monitoring or testing loops and trunks. A test tone is provided on the panel. Two jacks are provided on the panel which can be patched to a trunk circuit to designate it a common signalling channel. The space division module also has a special circuit patch panel which allows special terminal adaptors to be substituted or bypassed.

Each time division module has a patch panel associated with it. This panel allows monitoring/reassignment of digital groups and loops. The panel also allows bypass or substitution of trunk encryption devices and provides a generalized access to the time division switch matrix. The recovered clock from each digital transmission group makes an appearance on the time division patch panel. One of the recovered clocks may be patched to the master timing group plug on the panel. The master timing group has a control on the special circuits patch panel which selects which time division module will serve as the clock source, and the speed of that group. Master clock mode may also be selected by this control, causing the TTC-39 to operate on an internal clock source.

Traffic Control Functions--The TTC-39 has capabilities for measuring and controlling traffic. The traffic measurements are reported periodically to the TCCF. Table A-1 is a list of the traffic parameters measured.

The TTC-39 has two primary traffic control actuators - trunk restriction and traffic load control. Trunk restruction limits the number of calls of any given precedence which can seize trunks in a trunk group. Traffic load control restricts individual subscribers from using some portion of network facilities. Each subscriber is classmarked for a given level of traffic control. The levels are as follows:

TABLE A-1. AN/TTC-39 TRAFFIC PARAMETERS

R3	Calls blocked (by precedence) Calls delayed (dial tone delay greater than 1 second)
R4	Calls offered (by trunk group and by precedence) All trunk busy signals (by trunk group and by precedence)
R5	Average number of trunks busy (30 sampling by trunk group and by precedence) Calls offered (by trunk group) Calls blocked (by trunk group) Calls on incoming trunks (by trunk group) Calls blocked by common equipment (by trunk group)
R6	Calls preempted (by trunk group and by precedence)
R41	Total switch accesses by directly connected subscribers Total switch accesses by PBX
R44	Total switch accesses (by source and destination type - net, PBX, or direct subscriber)
R47	Calls completed (by switch code)
R54	Common equipment occupancy

- o Level 1 - No restriction
- o Level 2 - Trunk access restriction
- o Level 3 - Trunk access restriction
- o Level 4 - Switch access restriction
- o Level 5 - Switch access restriction

Under trunk access restriction, the subscriber is allowed to make local intraswitch calls but is prohibited from gaining access to interswitch trunks. Switch access restriction prohibits any use of the switch. When traffic load control is implemented, trunk and switch restrictions are independent. Level 2 TLC also includes Level 3 TLC and Level 4 includes Level 5.

The threshold for automatic application of TLC may be changed either manually by the switch supervisor or from the TCCF. Traffic load control is applied automatically when the traffic count exceeds threshold values. It may also be applied by the switch supervisor or by the TCCF.

Other switch functions which could be used for traffic control include:

- o Zone restriction
- o Call inhibit
- o Switch lockout

Zone restriction is a classmark associated with each trunk and loop. It references one of eight zone restriction tables in the switch. The table contains either a list of switch codes which the terminal may call or a list which the terminal may not call. Typical use of the zone restriction is to prevent world wide dialing from routine users' instruments.

Call inhibit is a table of switch codes to which no user can originate calls. The call inhibit feature would be useful for implementing destination code cancellation in response to a switch failure. Both the zone restriction tables and the call inhibit table can be modified either locally by the switch supervisor or by a TCCF message.

Switch lockout is a TCCF directive specifying that no traffic, originating or tandem, should be forwarded to the locked out switch. This directive could also be used to implement destination code cancellation.

A.1.2 The SB-3865 ( ) (P)/TTC - ULS

General Characteristics

The SB-3865 is a portable patch panel and common control circuit switch. The single unit switching function can service up to 30 channels; patching (or sole-user service) is available for up to 18 channels. The SB-3865 is also available in two-unit or three-unit configurations servicing 60 or 90 switched channels, and 36 or 54 patched channels, respectively. Each SB-3865 unit consists of two modules: switch and power. Multiple units may be stacked, though stacking is not a prerequisite for proper operation. The SB-3865 will be used in tactical situations as an access switch, stand-alone switchboard or a ULS network tandem switch. It will operate as a strategic PABX in the DCS.

Connectivity and Trunk Characteristics

The SB-3865 can operate as a tandem or end office. It must be able to connect with:

- o SB-3614
- o SB-3865

- o TTC-30
- o TTC-38
- o TTC-42

Thirty-four single channel terminations (WF-16) are available and are apportioned as follows:

- o Thirty for sole-user or switched service to DSVT or DNVT instruments
- o Three for Analog Voice Orderwire (AVOW) terminations associated with TDM group terminations
- o One for an AVOW path to the attendant

Single channel terminations can serve DSVT and DNVT digital loops or trunks, or a maximum of 4 four-wire analog lines. Table A-2 lists the acceptable analog modes of operation.

Three digital transmission group (DTG) terminations (CX-11230) are provided. The characteristics of the DTG's accomodated are:

- o Diphase or dipulse modulation
- o Types 1, 3, or 4a multiplex signal formats (MSF) at 8/9/16/18 channels per DTG
- o Type 2 MSF with 4½ channels per DTG

The SB-3865 can accommodate up to six Type L overhead channels. The bit positions of the overhead channel associated with signalling are, however, set to all ones (as are the bit positions associated with system control telemetry). Digital in-band, permutable - code word signalling is used instead.

TABLE A-2. SB-3865 ANALOG LINE TYPES AND TYPICAL INTERFACING EQUIPMENT

LINE TYPE	EQUIPMENT (SIGNAL SETS)	MODE OF OPERATION
I	AN/TTC-38 AN/TTC-30	4-Wire DTMF Confirmation Trunk
II	SB-3614	4-Wire DTMF 3 Digit Tone Burse PABX Trunk
III	CV-1919 SB-3082	4-Wire DTMF Converter Trunk
IV	NOT APPLICABLE	
V	TA-341 TA-720 TA-838	4-Wire DTMF, AC Supervised Loop, Local Battery

NOTE: 1. Reference Specifications

AN/TTC-38	EL-CP-0109-0001
AN/TTC-30	CP 420000
SB-3614	MIL-S-29354
CV-1919	SCL-4659
SB-3082	EL-CP-0000-0046
TA-341	SCL-1759
TA-720	CP 530000
TA-838	EL-CP-0061-0001

Figure A-2 is a pictorial representation of the termination, switching and patching facilities available in the SB-3865. Table A-3 describes the maximum connectivity requirements to be met by the 1, 2, or 3 unit configurations.

Individual trunks can be classmarked "Secure Traffic Only". This designation can be overridden via an attendant imposed classmark of emergency operation for the entire switch.

Routing

The SB-3865 routing table specifies one primary and one secondary trunk group for up to 16 switch identifiers, three of which are reserved for routine local calls to other units in a 2 or 3 unit stacked configuration.

A call-in-progress table of up to 16 entires will be maintained to prevent a ring-around-rosey condition occurring in the ULS. Preepmption is only attempted for calls having a precedence greater than routine after a non-preemptive search of the secondary route.

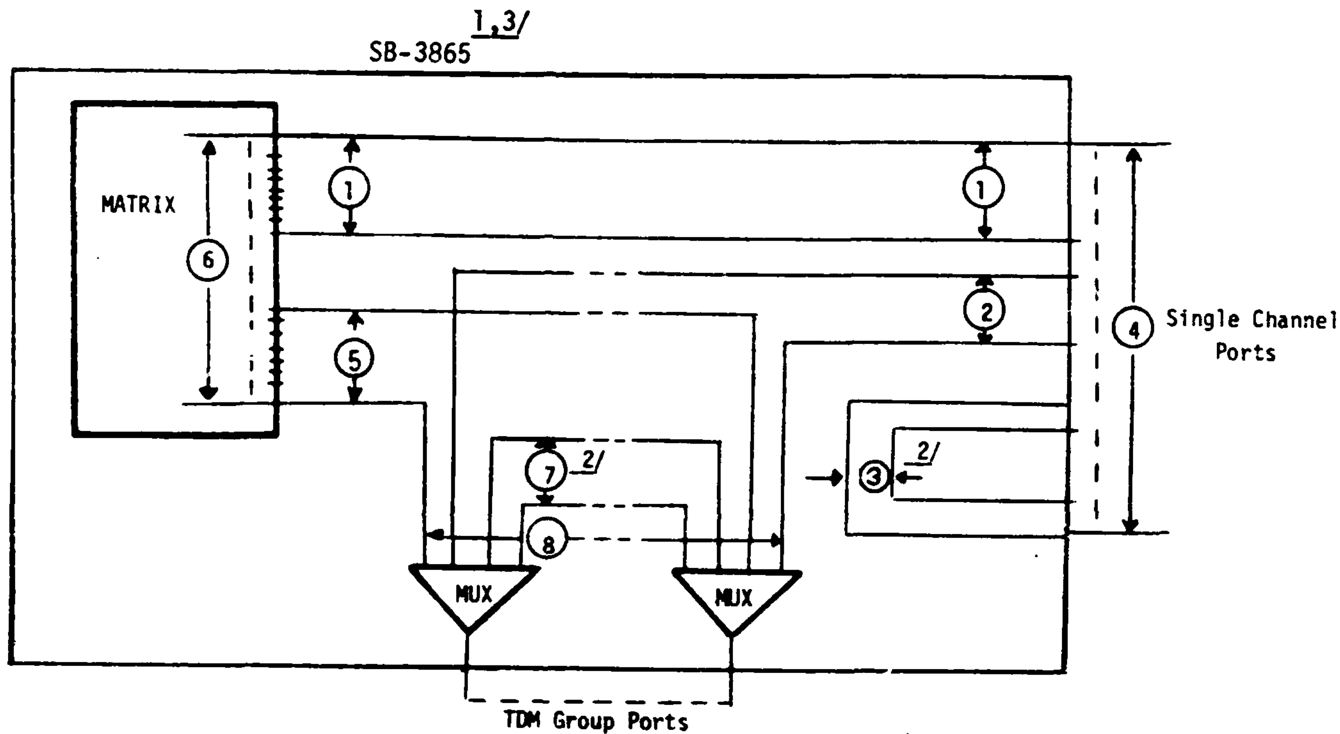
Hardware Description

The hardware for a basic SB-3865 unit consists of seven subsystems:

1. The Termination subsystem performs the functions necessary to interface the unit with the external transmission plant. This system can also connect with the Seeley Trunk Encryption Device (STED) to provide secure communications.

2. The Attendant subsystem provides the man-machine interface (MMI) to the SB-3865. The attendant has the ability to:

    o Perform supervisory functions



NOTES:

1. Category Definitions:
   - 1 Single Channel to Matrix
   - 2 Single Channel to Mux Channel Sole User
   - 3 Single Channel to Single Channel Sole User
   - 4 =1+2+ 2 x3Total Single Channel Ports
   - 5 Mux Channel to Matrix
   - 6 =1+5Total Switched Channels
   - 7 Mux Channel-Mux Channel Sole User
   - 8 =2+5+ 2 x7Total Mux Channels Served
2. Categories 3 and 7 count two channels per sole user.
3. This figure shall not be construed to impose a specific implementation.

Reference 30

Figure A-2. SB-3865 Connectivity Definitions

TABLE A-3. SB-3865 MAXIMUM SUBSCRIBER CONNECTIVITY REQUIREMENTS

CATEGORY	SB-3865	TWO UNIT STACK	THREE UNIT STACK
1. Single Channel to Matrix	30	60	90
2. Single Channel to Mux Channel Sole User	12	24	36
3. Single Channel to Single Channel Sole User	0	0	0
4. Total Single Channel Ports	30	60	90
5. Mux Channel to Matrix	18	36	54
6. Total Matrix Ports	30	60	90
7. Mux Channel to Mux Channel Sole User	6	12	18
8. Total Mux Channels Served	36	54	72

NOTE: 1. As defined in Figure 1.

- o Modify the switch data base
- o Reconfigure the switch functional assets
- o Manage the traffic metering assets
- o Access analog Engineering Orderwires (EOW)
- o Effect switch maintenance

3. The Memory subsystem will provide enough storage to perform the SB-3865 task with 20% excess capacity. The memory is accessible only from the control subsystem or the attendant position.

4. The Matrix subsystem operates under the direction of the control subsystem. It performs the functions and provides the facilities required to make up to 15 full duplex connections.

5. The Control subsystem is responsible for:

   - o The detection of a call for service
   - o The interpretation of the requirements of a call for service
   - o The assembly and allocation of a necessary switching resources
   - o The performance of maintenance and diagnostic functions

6. The Timing subsystem has the capability to generate, retime, divide and distribute the local timing signals in a manner such that the SB-3865 can operate either as a master or slave. This system will be able to flywheel for up to 0.5 seconds.

7. The Power subsystem accepts 120/240 volts at 50/60 or 400 Hz, or 24 volts DC. This is converted and distributed as necessary to the other subsystems.

Software Description

The software for the SB-2865 is specified as follows:

1. The Executive program maintains general cognizance of the switch's operations, processes I/O requests, schedules functional programs on a priority basis, directs maintenance programs, exercises the facility via on-line maintenance programs and control hardware interrupts.

2. The Operational Program performs real-time functions, call processing functions and the necessary background procedures.

3. Maintenance programs are capable of identifying a failure to a lowest replaceable unit (LRU). They consist of fault detection (i.e., diagnostic and routine) and fault isolation programs.

   Routine functions include, but are not limited to:

   - Table cross-checking.
   - Verification of matrix, receiver/sender, memory, controller and also the executive system.
   - Determine necessity of control switchover in a multi-unit stack.
   - Loop, in-band trunk and analog trunk testing.

   Subsystem failures result in a major alarm; transmission plant failing a routine test is marked for maintenance, and the attendent is alerted via a status indicator. A major alarm consists of an audible alarm, and visual alarm indicating the failure.

4. The Recovery program provides the intelligence necessary to transfer control from one unit to another in a multi-unit stack.

5. The initialization program is started from the switchboard and is capable of bringing the SB-3865 up from a cold start, or restarting after a system failure.

System Control Parameters

The SB-3865 is designed to measure and locally record the following traffic parameters in six hour increments:

1. Total number of originated loop calls, either routine or precedence.
2. Number of trunk group originations, either routine or precedence.
3. Number of ATB's encountered - not preempt failures.
4. Number of calls preempted per trunk group.

Other parameters that might be considered for network analysis purposes are the number of attempts encountering dial tone delay or call completion delay.

System Control Capabilities

The SB-3865 can accommodate up to six Type L overhead channels. the three bits in each Type L channel are, however, set to all ones (as are the signalling bits) eliminating the built in system control telemetry capability. None of the locally recorded traffic information is telemetered to a SYSCON facility. The SB-3865 provides for four single channel WF-16 type terminations for AVOW service. Three of these are associated with TDM group terminations. The fourth is an AVOW to the ULS attendant. AVOW information is carried over a DTG via superimposition.

Available System Control Actions

The SB-2865 is designed to operate either unmanned or manned. It has no ability to perform automatic system control functions. The attendant can locally bar trunk-to-trunk or loop-to-trunk calls on a per termination basis.

A.2 CHARACTERIZATION OF AUTODIN II

The AUTODIN II system in the time frame of this study will consist of three packet switching nodes (PSN) and a Sub-Network Control Center (SNCC) deployed in Eurpoe. The SNCC will be an exact copy of the NCC in CONUS with the exception that it will readdress and transmit all reports received from the PSN's to the NCC. The SNCC will be colocated with the ACOC in Vaihingen and will be dual-homed to the DIN network. According to the deployment model for this study, the PSN's will be located at Croughton, Coltano and Pirmosens. Croughton and Pirmasens are gateway switches to the CONUS portion of the network.

In addition to individuals, both ATEC and the DSCS Control Segment will use the AUTODIN network to transfer information to ACOC which is a singly homed subscriber. The SNCC will also use the DIN II network to relay 55-1 messages to ACOC as necessary.

The next two sections contain characterizations of the AUTODIN II PSN and the NCC, respectively.

A.2.1 The AUTODIN II Node

Functions of an AUTODIN II Node

The AUTODIN II node performs two primary functions.

- o The tandem function, which is to route each packet to a proper back-bone trunk.

- o The regional functions, which is to connect access lines to the packet switching node (PSN)

Additional functions performed by the PSN are:

- o Security level and Transmission Control Code (TCC) checking.
- o Traffic acceptance and flow control.
- o Traffic and management statistics gathering and reporting.
- o Error control.
- o Synchronization.
- o Traffic delivery acknowledgment.
- o Data transfer protocols.
- o Routing table control.
- o Hardware fault detection and correction.
- o Interfacing and exchange procedures for the use of satellites.

<u>DIN II Node Hardware</u>

The tandem function is performed by a Switch Control Module (SCM). There can be as many SCM's at each node as are required to support the local traffic load. Each SCM is a DEC PDP-11/70. For the case of a multiple SCM node, a Parallel Communications Link (PCL) interface supports intra-nodal communication.

The termination function is performed by:

- o Terminal access controllers (TAC) which connect single or multiplexed terminals to the SCM. The TAC is a PDP-11/70.

- o Single Channel Control Units (SCCU), which connect one host processor each to the SCM. The SCCU is a PDP-11/04.
- o Multiple Channel Control Units (MCCU), which connect up to 32 host processors each to the SCM. The MCCU is a PDP-11/34.
- o Interactive Control Units (ICU), which connect asynchronous subscribers.

See Figure A-3 for an overview of the units that comprise a PSN.

In addition to backbone trunks, the PSN must be able to terminate hosts and terminal subscribers either directly or via:

- o AUTODIN II trunks
- o AUTOVON trunks
- o Common carrier networks
- o Switched networks

<u>Patch and Test Facility (PTF)</u>-- All connections to the PSN are made through the PTF. This allows the tech controller to be aware of the status of all communications equipment and circuits within the PSN and to take action to correct any deteriorization or failure of this equipment. To this end, the PTF provides:

- o Distribution frames
- o Patching (switching) frames
- o Isolation areas
- o Monitoring and reporting facilities
- o Control equipment

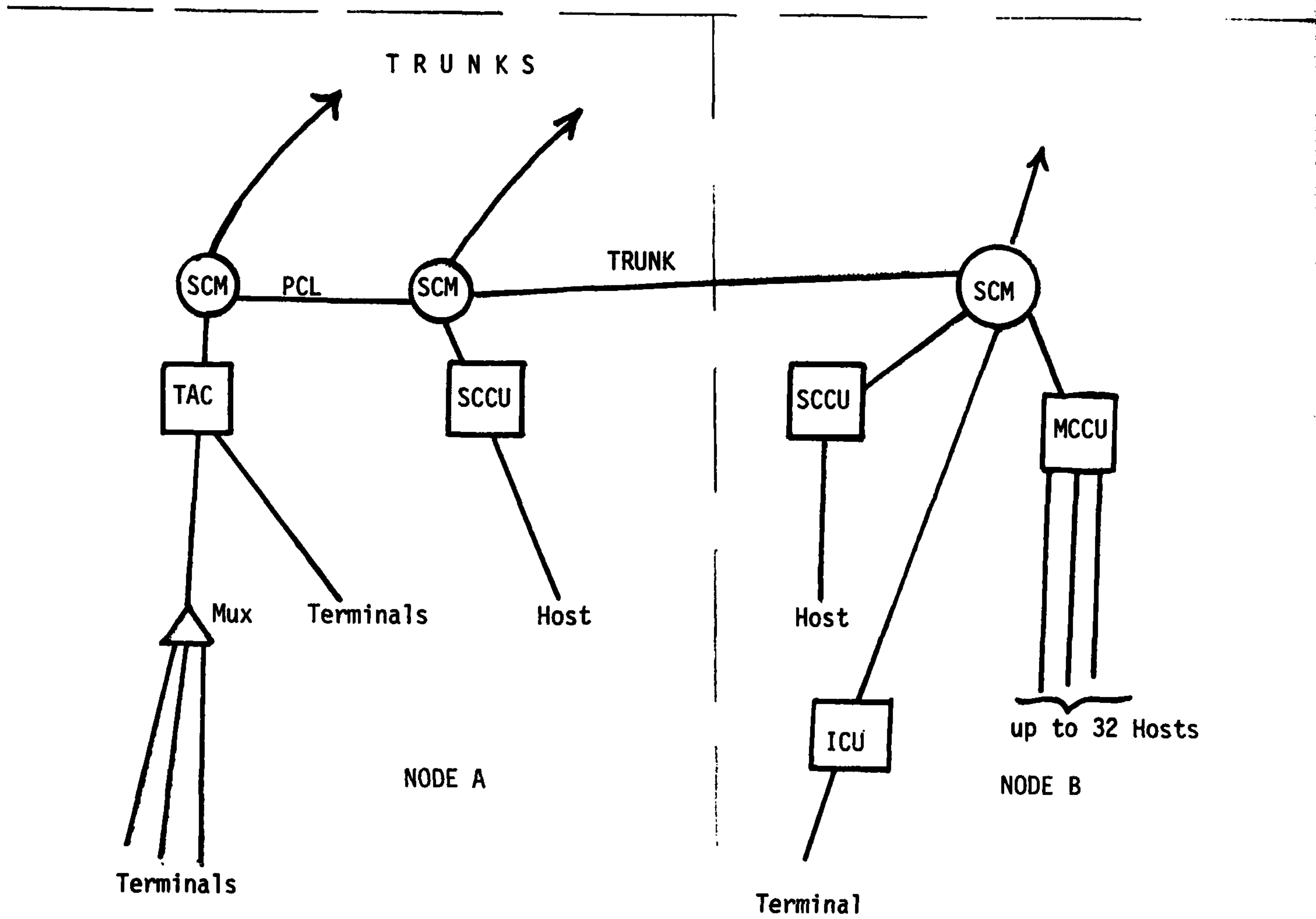


Figure A-3. DIN II Network Overview

The tech controller at a PTF can monitor all equipment associated with the PTF (e.g., modems and cryptos). The PTF supports the controller with visual and audible alarms, and provides for controller to NCC communications. Orderwires and AUTOVON access to the NCC and WWOLS are also available to the PTF controller.

DIN II Node Performance

The typical DIN II node will process approximately .5 Mbs to 2.5 Mbs. It will terminate 50 to 192 full duplex connections.

Category I calls are to be handled in a non-blocking fashion. One out of 100 calls of the categories II, III and IV are allowed to incur delays of 5, 10 and 30 seconds respectively. Average through network delay for all packets shall be less than .1 second.

Connection of Two Nodes and Flow Control

When setting up a potential connection between source and destination, both nodes must locate adequate buffer space (called a Bookkeeping Block - BKB) in which to hold the packets. If none is available, a blockage is recorded. The size of the buffer available in the destination PSN is also important. Therefore, the number of packets which the destination can receive is a parameter returned to the source PSN. This parameter is used as a window size, i.e., the source may never allow more than that number of packets into the network for the particular logical connection being established. The destination node acknowledges packets as it receives them; generates time-out, discard and retransmit reports as necessary; and it transfers received packets to the intended subscriber in the order received. Packets are numbered sequentially at the source node to facilitate the reassembly, retransmit and discard/reject functions.

Routing and Routing Table Update Control

When a segment is formatted for transmission, the destination node address in the segment header is used as an index to the routing table from which a backbone trunk is selected. The segment is then moved to a queue for that trunk. Once the segment is transmitted, the segment is automatically moved to a retransmit queue where it waits for either:

- o An acknowledgment, in which case it is purged from the retransmit queue.
- o A destination switch timeout, in which case it is automatically retransmitted.

Packets entering the node from the network are similarly dispersed via the routing table look-up method.

A by-product of the AUTODIN II acknowledgment procedure is the measurement of source-destination delay. The node software examines the delay times and routes of all segments it passes to the network to determine the accuracy of the current routing table. If it determines that the current route is not the quickest available, a new route is developed. All switches are informed of the new route and update their routing tables accordingly.

DIN II Node Modes of Operation

With respect to data collection, there are four modes of operations for a DIN II node:

1. Normal - only background trace in progress.

2. Performance Monitoring (PM) - PM statistics being gathered and PM reports being generated periodically or as necessary to avoid counter overflow.

3. Test Mode (TM) - The network is loaded to a desired level and reported upon accordingly.

4. Netowrk Reconfiguration Engineering (NRE) Date Collection - Specific statistics to support network planned are collected.

Background Trace--To best manage the packet network, detailed performance information is required by the Network Control Center (NCC). Some of this information is gathered from all nodes in the form of the background trace. The NCC controls the rate at which information is gathered by changing a variable in each node's data base. The result is that one out of N segments have the trace bit set in the segment leader. This bit is checked in every segment handled by each node. A set bit generates a "packet trace report" addressed to the NCC. The information contained in this report details the time of arrival, through-node processing time and the size of the packet involved.

Test Mode--The NCC operator has the ability to put the network into the test mode. In this mode, each SCM randomly routes test packets through the network simultaneously with normal traffic. The result is that the network is loaded to the NCC operator-selected level for test purposes. Test packets are discarded when they arrive at their destination, but their presence is noted via Test Packet Reports and other statistics routinely gathered by the SCM's and the NCC.

Performance Monitoring--The NCC operator has the ability to select nodes for performance monitoring via a control message. In this mode, the PSN generates detailed statistics concerning switch and user throughput.

Network Reconfiguration Engineering Data Collection (NREDC)--The NCC operator has the ability to put the entire network into the NREDC mode. In this mode, detailed reports are generated which describe the size and precedence distribuiton of all packets handled by each originating PSN.

Reports to the NCC

One of the hosts dual homed to the DIN II system is an administrative complex called the Network Control Center (NCC). The NCC is equipped with software that, among other things, examines long and short-term trends within the network, and also randomly occurring disruptions. The NCC Data Management Software collects the required information from the nodes in the form of report packets of which there are basically two varieties:

- o Occurrence reports
- o Periodic reports

The NCC Data Management Software peruses the data contained in these reports as they appear and maps them into various data sets and CRT displays. The NCC operator is notified if any of the reports reveal a serious disturbance at hand, or if the trending algorithms predict an imminent disturbance.

If isolated from the NCC, each PSN can retain all the information generated by these reports until the NCC comes back on line. Alternatively, WWOLS can also journalize all NCC intended reports.

All reports have a fixed header that identifies:

- o Report ID number
- o Source switch ID number
- o Report sequence number
- o The time of the report

Table A-4 lists all PSN to NCC reports according to Report ID number and specifies the type of report. Figure A-4 shows a typical report template.

Occurrence reports are generated as appropriate to the situation at hand. Some occurrence reports are initiated in response to a command from the NCC, e.g., the Computer Diagnostic Test Report. For this reason, reports generated on demand are considered to be occurrence reports as they are generated when the action demanded by the NCC is completed. A brief description of the occurrence reports (as per AUTODIN II DESIGN PLAN - VOLUME 8, 26 August, 1977) follows:

1. Acknowledgment Report - The acknowledgment report serves as verification that the indicated NCC generated control message has in fact been received by the PSN. It also contains a single bit indicator that implies PSN operator acceptance or rejection of the control message.

2. Blocking Report - The blocking report identifies the duration of the blockage and the destination processor involved.

3. Discard/Reject Report - This report details source, destination, category and type of all discards encountered. Reasons for discard include:

TABLE A-4. PSN TO NCC REPORTS

Report ID #	Report	Report Type
1.	Billing Report	P
2.	Buffer Utilization Report	P
3.	Retransmission Report	P
4.	Multireport Packet	P
5.	Total Flows/Preemptions Report	P
6.	Acknowledgement Report	O
7.	Blocking Report	O
8.	Discard/Reject Report	O
9.	Failure/Configuration Report	O
10.	Improper Patch Report	O
11.	Node Parameter Change Report	O
12.	Packet Trace Report	O
13.	Timeout Report	O
14.	Test Packet Report	D or OV
15.	Computer Diagnostic Test Report	D
16.	Line Diagnostic Test Report	D
17.	Software Task Report	O
18.	Flow Report	PM
19.	Switch Volume Report	PM
20.	User Segment Length Report	PM or OV
21.	User Volume Report	PM
22.	Switch Packet Length Report	R
23.	CRT to CRT Report	O

P = Periodic
O = On Occurrence
D = On Demand
PM = Performance Monitoring
OV = Overflow
R = Reconfiguration Data Collection

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0				
REPORT ID		SWITCH ID		
REPORT SEQUENCE NUMBER				
TIME				
RECEIVING SCM		TRANSMITTING SCM		packet / segment header extract
*	NODE 4 TRAVERSED	NODE 3 TRAVERSED	NODE 2 TRAVERSED	
**	NODE 7 TRAVERSED	NODE 6 TRAVERSED	NODE 5 TRAVERSED	
PACKET ID NUMBER		SPARE		
PRECEDENCE	SECURITY	TCC		
SOURCE ADDRESS				from header (if present) or from BKB (if available)
DESTINATION ADDRESS				
TIME IN				
TIME IN (CONT.)				
TIME OUT (OFFSET)				

* This bit will be set whenever an SCM receives the packet from a trunk or TAC.

** This bit will be set whenever an SCM transmits the packet to a trunk or TAC.

Frequency : On occurrence
Report Length : 13 words
Report ID : 12

Reference 7 — Packet Trace Report

Figure A-4. Sample PSN to NCC Report

- o Precedence violation
- o Security violation
- o TCC violation (Transmission control code)
- o Excessive connections
- o Segment/packet error
- o Destination switch out-of-service (OOS)
- o Destination subscriber OOS
- o Looping
- o Duplicate packet
- o Excessive time in line queue
- o Connection pending
- o Flow control
- o Preemption
- o Source BKB unavailable
- o Test packet

4. Failure/Configuration Report - This report contains a Reason for Outage (RFO) or a Trunk/Line ID and a status word appropriate to either the RFO or ID.

5. Improper Patch Report - This report identifies the fact that an improper trunk or access line patch has occurred.

6. Node Parameter Change Report - This report identifies a change to the data base of the source node. If the reason for the change is an NCC Control Message, the PSN operator may reject the change. This report will carry notice of rejection, if it occurs. This report is also generated each time a node operator interacts with a node computer such that the NCC will have a complete record of all PSN operator actions.

7. Packet Trace Report - This report is generated whenever an SCM encounters a packet in which the trace bit is set. (The bit may be set to support normal background trace activities, or to support detailed performance monitoring as requested by the NCC.) Other information contained in this report details:

   - Receiving and transmitting SCM ID's.
   - Nodes traversed by the packet.
   - Packet ID, source and destination.
   - Time into the SCM.
   - Amount of through-node processing time encountered.
   - Whether the report is generated upon input to or output from the SCM.

8. Timeout Report - This report is generated when a timeout occurs. It details:

   - Source and Destination Addresses.
   - Packet precedence, security and Transmission Control Code (TCC).

- ID of the SCM or node that timed out.
- Type of time out:
  - Output Queue
  - Input Queue
  - Frame Control ACK
  - Hold Queue
  - Saturation (blocking)
  - Transmission Control Program

9. Test Packet Report - This report is delivered when the network is taken out of the test mode, or when a counter overflows. It indicates the disposition of test packets.

10. Computer Diagnostic Test Report - This report is delivered upon a completion of NCC - requested SCM diagnostics, or if the PSN operator rejects the diagnostic request. It identifies the tested computer, the particular diagnostic and the checksum result.

11. Line Diagnostic Test Report - This report serves as acknowledgment that a request for line diagnostics was received and may indicate PSN operator rejection of the request. The contents of the report are the line ID and diagnostic test results which will be compared with an expected results table in the NCC.

12. Software Task Report - The task report provides a means of verifying the contents of PSN software at the NCC. A series of these reports is used to transmit a copy of the task, its checksum, its ID and the node computer ID to the NCC where the contents are verified. This occurs each time a new module is loaded at the PSN

(if security allows) and also periodically to verify all software.

13. Flow Report - This is a performance monitoring report generated each time a connection is terminated. The information provided consists of:

    - o Source and destination addresses
    - o Precedence
    - o Preemption Flag
    - o Time connection established
    - o Length of connection
    - o Total number of data segments transmitted

14. NCC/Switch CRT to CRT Communication - This report supports ad hoc communications requirements. The PSN operator has the ability to transmit any text to the NCC via this report.

15. Switch Packet Length Report - This report allows the NCC to collect statistics to be used specifically for network reconfiguration engineering (NRE). The NCC operator initiates NRE data collection in each SCM via a control message. It is assumed this data will be collected during peak busy hour. Originating PSN's keep running counts of the number of packets distributed to the network in each of 10 bin sizes for the 16 precedence levels. At the end of the NRE data collection interval, one Switch Packet Length Report detailing these counts is sent to the NCC for each PSN receiving packets from the subject PSN.

Periodic reports are generated according to a schedule resident in each PSN's data base. Either the PSN or NCC operator may modify each report's period individually. Some periodic reports are also generated if the counters upon which they report are about to overflow. A brief description of the periodic reports transmitted from PSN's to the NCC (as per AUTODIN II DESIGN PLAN - VOLUME 8, 26 August, 1977) follows:

1. Billing Report - The billing report describes the number of segments of each category type a group of subscriber/user pairs entered into the network.

2. Buffer Utilization Report - This report has a minimum period of 30 seconds. It describes:

   o Available bookkeeping blocks (BKB)

   o Available transmission buffers

   o For Category I service and for categories II through IV as a group:
     - Task, input, output and holding queues assigned
     - BKB's assigned

3. Retransmission report - This report describes:

   o Number of lines reported on this report

   o Number of segments received

   o Number of segments received in error

   o Number of segments transmitted

   o Number of segments retransmitted

A complete set of data is provided for each line ID encountering retransmissions. The line ID is used to derive the line type and rate by the NCC.

4. Multireport Packet - This report is used to group together up to 16 reports with low priorities. The eight words following the report header describe the lengths of the sixteen following reports.

5. Total Flows/Preemptions Report - This report describes the following information separately for each category (I - IV) since the last report:

   o Number of preemptions

   o Number of flows formed (connections)

   o Number of flows broken (terminations)

   o Number of flows active (in progress)

6. Switch Volume Report - This performance monitoring report details:

   o The number of data packets transmitted and received

   o The number of control packets transmitted and received

   o The index for packet counts by precedence

   o The total number of packets in each of the 16 extended precedence levels (the four categories by the four types of flows).

7. User Segment Length Report - This performance monitoring report describes the number of segments of each bin length (there are 10)

for each of the 16 precedence levels available to the specified number of subscriber/users.

8. User Volume Report - This performance monitoring report describes for a variable number of subscriber/users:

   - o Total number of data packets received and transmitted
   - o Total number of control packets received and transmitted
   - o Number of input segments by the 16 precedence levels
   - o Total number of flows

Summary

Each PSN collects quantities of data concerning network throughput and performance which is subsequentally delivered to the NCC. This data is managed at the NCC such that the NCC operator is continuously informed about overall network status and accurate usage records are maintained for billing purposes. None of the data delivered and processed at the NCC affects the real-time control of the AUTODIN II network. The real-time control resides in the precedence, flow control and routing table control software of each PSN.

A.2.2 THE AUTODIN II Network Control Center (NCC)

NCC Functions

The DIN II NCC is designed to perform three functions which are integral parts of the DCAOC (Defense Communications Agency Operations Center):

- o The daily system control and operational direction of the DIN II network.

- The correlation of individual node and subscriber actions and conditions to provide a meaningful view of the numerous real-time reactions that take place simultaneously around the network.[1]
- The control and management of AUTODIN I.

In addition, the SNCC deployed in Europe will automatically readdress and transmit all reports received from the PSN's to the NCC in CONUS.

NCC Hardware and Configuration

The NCC is a dual homed subscriber of the Packet Switched Network. The NCC functions are performed by a PDP-11/70 which supports a system console, four CRT's, two line printers, over 44 million words of mass storage, three disk, three tape and two floppy disc drives. It is connected to two Packet Switch Nodes (PSN) to ensure its contact with the network. The NCC communicates to the World Wide On-Line System (WWOLS) via the packet switch network, i.e., there are no special connections from the NCC to WWOLS.

NCC Degraded Operation

In the event that the NCC cannot record billing and performance information, all appropriate information will be routed to and journalized at WWOLS until such time as the NCC has recovered.

Data Collected by NCC

The NCC receives data from the PSN's in the form of report packets of which there are two varieties:

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[1] George E. Schaft, Computer Sciences Corporation, "The AUTODIN II Network Control Center", Paper #37:5-1, NTC '77 Conference Record, Vol. 3.

- o Occurrence reports - e.g., exception reports, responses to NCC stimulus.
- o Periodic reports - e.g., billing reports, performance and usage statistics.

The amount of data of each type collected depends on the mode of operation of the network. The NCC operator has the ability to put any node or number of nodes into any one of three accelerated data generation modes. Therefore, there are four modes of operation of the network:

1. Normal - only background trace and routine usage monitoring in progress.

2. Performance Monitoring (PM) - PM statistics being gathered and PM reports being generated periodically or as necessary to avoid counter overflow.

3. Test Mode (TM) - The network is loaded to a desired level and reported upon accordingly.

4. Network Reconfiguration Engineering (NRE) Data Collection - Specific statistics to support network planning are collected.

Normal--To best manage the packet netowrk, detailed performance information is required by the Network Control Center (NCC). Some of this information is gathered from all nodes in the form of the background trace. The NCC controls the rate at which information is gathered by changing a variable in each node's data base. The result is that one out of N segments have the trace bit set in the segment leader. This bit is checked in every segment handled by each node. A set bit generates a "packet trace report" addressed to the NCC. The information contained in this report details the time of arrival, through-node processing time and the size of the packet involved.

In addition to trace information, billing and resource utilization statistics are routinely gathered and reported to the NCC in this mode.

Test Mode--The NCC operator has the ability to put the network into the test mode. In this mode, each node randomly routes test packets through the network simultaneously with normal traffic. The result is that the network is loaded to the NCC operator-selected level for test purposes. Test packets are discarded when they arrive at their destination, but their presence is noted via Test Packet Reports and other statistics routinely gathered by the nodes and the NCC.

Performance Monitoring--The NCC operator has the ability to select nodes for performance monitoring via a control message. In this mode, the PSN generates detailed statistics concerning switch and user throughput.

Network Reconfiguration Engineering Data Collection (NREDC)--The NCC operator has the ability to put the entire network into the NREDC mode. In this mode, detailed reports are generated which describe the size and precedence distribution of all packets handled by each originating PSN.

NCC Data and Processing

A. Data Input--The data gathered by the PSN's operating in the four modes described above arrive at the NCC as 23 reports concerning:

- o Packet throughput by precedence
- o Retransmissions
- o Buffer utilization by precedence
- o Security mismatch (on occurrence)
- o Fault occurrence which might cause compromise
- o Time log of switch operator's actions
- o Acknowledgment that an NCC directive has been implemented (on occurrence).
- o Switch hazardous condition (on occurrence)
- o Program reload and restart (on occurrence)
- o Packet Preemption and discard information
- o Packet traces (on demand)

B. Input Processing--From 23 types of reports, the NCC collects three basic types of data about the PSN's and the DIN II network:

1. Disturbance information
2. Billing information
3. Performance information

The data are perused and reduced to appropriate data files and sets that support:

1. Ten printed report files, which provide long term data summary and analyses on a daily basis or on demand concerning:

   - o Network Packet Processing Time
   - o Network Trunk Performance and Utilization
   - o Network Access Circuit Utilization and Performance
   - o Network Quality of Service
   - o Network Flows, Blockages, and Preemptions
   - o Switch Performance
   - o Single User Performance
   - o Multiple User Performance
   - o User Segment Length
   - o Community of Interest Reports

2. Seventy CRT Network Status Displays, which provide near real-time information to the NCC operator. When a report arrives at the NCC, the operator is advised by an audible and visible alarm. The highest level display, the Network Disturbance Summary, will indicate the source of the report and direct the operator via a menu to a set of more specific displays. The lower level displays are grouped as follows:

   - o Switch Status Displays, which provide data about each node.
   - o Trunk Status Displays, which summarize backbone information.

- o Line/Host Displays, which summarize disturbances and operations for each node.
- o Packet Processing Time Displays, which summarize end-to-end and through node processing times for all categories of traffic.
- o Reporting Status Displays, which summarize problems, thresholds and outstanding reports for all nodes.

3. The trending analysis programs, which attempt to predict network overloads and breakdowns as functions of:
   - o Blockages recorded throughout the network
   - o Preemptions
   - o Buffer utilization
   - o Processing delays
   - o Timeouts
   - o Retransmissions

   Each of these six parameters can indicate one of three conditions:
   - o No problem
   - o Trending toward a problem
   - o Currently in a problem

   These conditions are summarized on a per switch basis in the Network Disturbance Summary display. If newly processsed trend data causes a change to the Network Disturbance Summary, the NCC operator is alerted by an audible alarm.

4. Automatic notification of WWOLS in the event that a critical switch outage occurs.

NCC Operator Control Actions

There are 12 canned message formats provided to facilitate NCC operator communications with the PSN's. Using these, the NCC operator can request the following from any PSN:

- Detailed trace information concerning specified source/destination pairs.
- A change in the rate at which background trace information is generated.
- Initiation of line or processor diagnostics.
- A dump of any exception report record.
- A change in the rate at which routinely generated reports are delivered to the NCC.
- A dump of the currently available performance data.

Canned formats also exist for communications with WWOLS, AUTODIN I, and ad hoc messages with a PSN CRT facility.

Neither the NCC operator nor the NCC itself have the ability to perform any real-time control actions on the network. Based on information gleaned from the CRT displays and printed reports the operator can request more connectivity, or request that lower priority traffic be deferred by hosts. However, the real-time operation of the network depends on the flow control, routing table update and precedence algorithms built into the PSN software.

Summary

The NCC and NCC Operator perform a passive, watch-dog function with respect to the packet network. The operator can control the rate and amount of performance data collected for analysis from the network, but cannot actively control the network itself. Because of the amount of data collected by the NCC and the global view it is afforded, the NCC is very important in network planning that can in non-real time significantly improve network performance. The NCC software contains a data base management system (DBMS) that allows the NCC operator access to near real-time network status displays and extensive batteries of non-real time performance and subscriber usage data. This data accurately supports billing procedures, and also provides management backup information concerning the specific amount of service provided subscribers.

Though the NCC is not critical to the operation of the network, it does enhance the overall performance and support of the network.

A.3 CHARACTERIZATION OF DSCS CONTROL SEGMENT

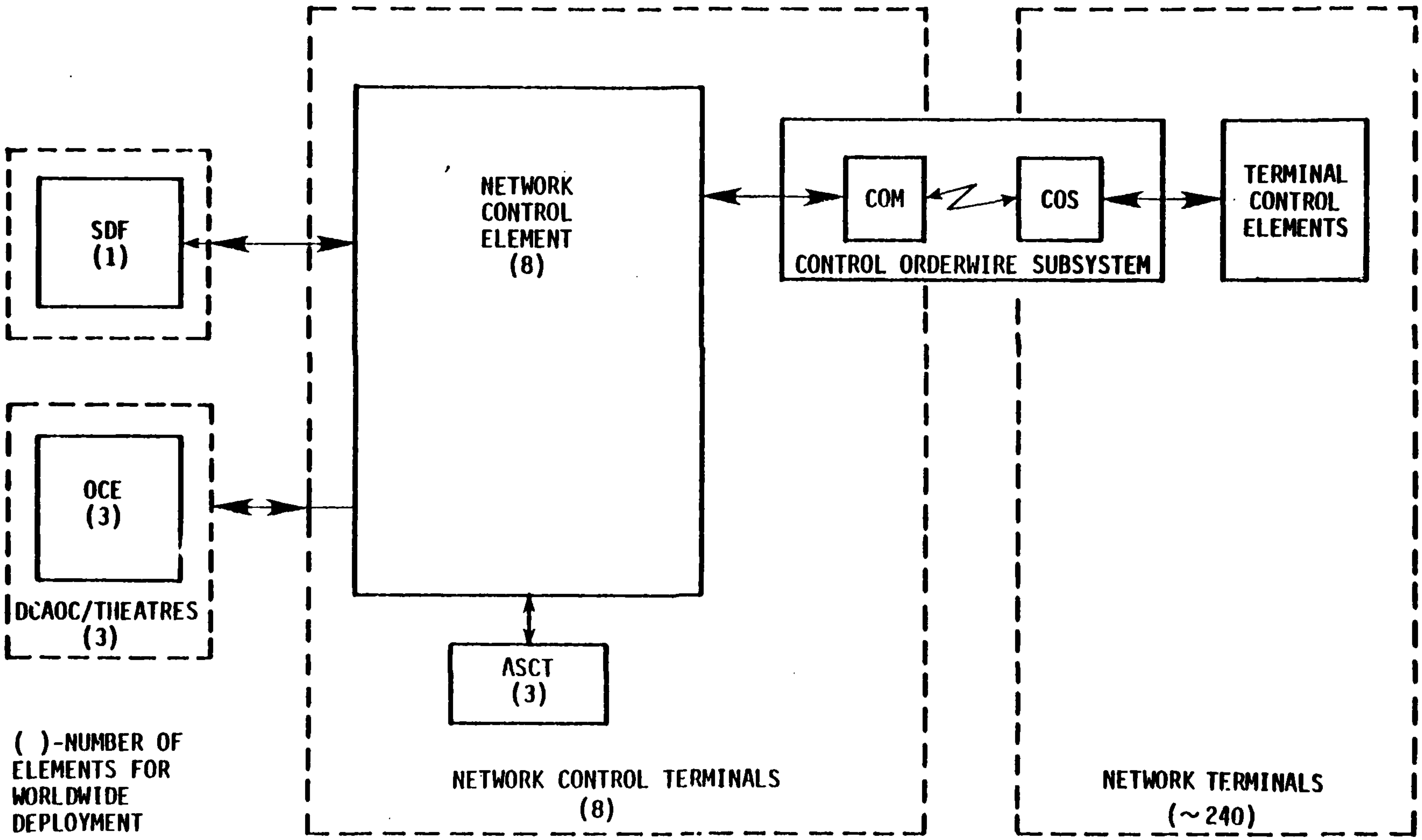
The general role of the Control Segment is the adaptive control of the overall satellite network. That network must service the communications needs of the DCS as well as a number of dedicated users such as NATO, Ground Mobile Forces (GMF) and others. It is therefore reasonable to possess a distinct control mechanism for this overall subsystem. The needs of the DCS will be serviced as they fit within the entire demands placed on the satellite system. The elements of the DSCS are shown in Figure A-5.

The primary function at the OCE is to remain aware of the communication status of the entire system and plan for changes as required. The NCE is the main workhorse of the overall system in that it has the primary role of implementing any configuration changes requested by the OCE, and of evaluating candidate reconfiguration. The TCE is the lowest element in terms of responsibility within the CS. It supports control of a single earth terminal. The Control Orderwire Subsystem (COSS) interconnects all control segment elements using voice, TTY, High Speed Data (HSD) and secure communication links.

The general relationship between the DCS System Control hierarchy and the CS of the DSCS is shown in Figure A-6. Note that there is no commonality or similarity at the sector level since most of the communication requirements placed on the DSCS are long haul or intersector in nature.

Relationship of Air Force Satellite Control Facility (AFSCF)--Prior to the formal design of the Control Segment of the DSCS, satellites were under the direct control of AFSCF. In fact, the format for this type of control is still used in second generation satellites.

The necessary control system for the DSCS is now reaching the point where the AFSCF may be limited in its responsibility. With the advent of DSCS III, general control of the satellite will become a responsibility within the DSCS/CS. Specifically, position and health of the satellites will now



Reference 22

Figure A-5. Control Segment Functional Block Diagram

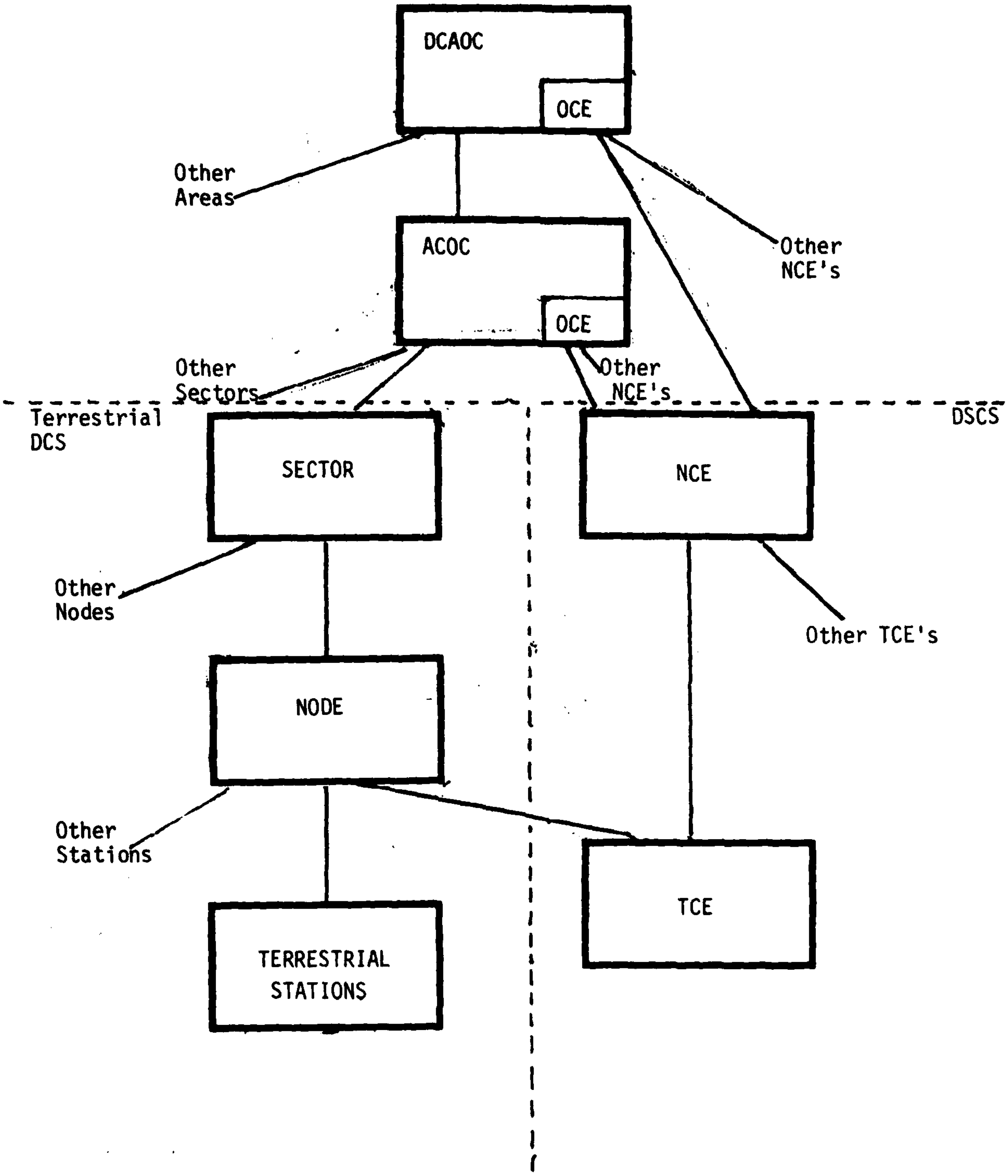


Figure A-6. DSCS Control Segment in Relation to the System Control Hierarchy become the responsibility of the Satellite Configuration Control Element which is a distinct processor associated with a particular NCE.

Special Networks--While the DSCS does provide facilities to groups other than the DCS, this service is provided on a "special network" basis. The facilities are provided on a full time basis and, in general, cannot be reassigned. The DSCS/CS keeps track of these dedicated facilities via data received from one element in the dedicated network. This element is designated as the point of contact and serves as a subnetwork control element. All operations reports, trouble messages, etc., from the subnetwork are sent first to this element, then to the responsible NCE and finally the information is transferred to the OCE, if required.

Time Limit Specifications--The design goals for time limits for particular operations within the DSCS are as follows:

Calculation of reconfiguration	10 minutes
Resource allocation action	1 minute
Switch to back-up NCE for Net	10 minutes
Mean Time to Restore OCE	10 minutes
Mean Time to Restore NCE	30 minutes
Mean Time to Restore TCE	10 minutes

OCE Description

The OCE is intended as a single point, major control function. Status reports are available to the OCE on a demand basis. The OCE may implement changes within the DSCS by requesting the change via the NCE function. The NCE evaluates the feasibility of the request and implements it if it is possible.

OCE's are located at the DCA Operations Center and at the Theatre Level Control Centers. Each OCE has the primary responsibility for one or two of the four satellite networks (Atlantic, Western Pacific, Eastern Pacific, Indian Ocean). The DSCS Control Segment specifications define a complement of hardware for the OCE, as discussed later. However, the OCE is actually supporting the overall function of Network Connectivity Control performed at ACOC or DCAOC. Therefore, the Transitional System Control study has recommended that the functions of the OCE can be implemented within the computer system which supports Network Connectivity Control.

Thus Network Connectivity Control, using OCE functions, evaluates alternative transmission network configurations. If changes to the DSCS are required, they are sent to the NCE's involved. The NCE evaluates their feasibility and then verifies that the solution can be implemented or the solution cannot be established as a new configuration. No OCE solution is placed into action until agreement of the NCE's involved in obtained. In this respect, the OCE can be considered as a planning unit rather than an action unit (such as the NCE).

Even though the OCE will not normally request any reconfiguration without express NCE approval, this could happen in the event that the problem is more widespread than any single NCE can comprehend. In this case, the DCAOC/OCE may be required to take control of all networks to coordinate demands from all three theatres. In this respect, the OCE is in charge of the operation of reconfiguration even though it does not take the implementation action directly as a responsibility.

Each OCE is directly connected to a subset of the NCE's. Note that there is a primary facility and a back-up NCE for each satellite. The OCE is active via the primary facilities in most cases; direct connection of the back-up NCE facilities to the OCE is only established in the event of serious failure of the primary system.

Each satellite has a corresponding "net" of terminals within its responsibility. In general, there is a capability for up to 60 terminals within each of the four nets. This yields 240 total terminals within the realm of the DSCS.

Hardware Description--In order to implement the overall planning and control function, each OCE is specified to possess a dedicated 16 bit processor with a full complement of peripheral input/output units such as a mag tape drive, printer, disc, etc. The size of the OCE memory is specified at 512 KBytes as an initial main memory with growth capability up to 10 MBytes of memory.

Off-the-shelf hardware and software is recommended for the OCE wherever this option is possible. In addition to the processor and I/O equipment, the OCE is currently specified to contain a Controller Interface Terminal (CIT) and a Baseband Interface Subsystem (BIS). These units are to provide normal connection to the processor for the controller and communication equipment respectively.

NCE Description

The Network Control Element is by far the most complex and most active unit found within the overall DSCS/CS. As presently planned, the functions to be performed by each NCE are as follows:

a) Link Establishment Control

b) Network Resource Allocation

c) Network Performance Analysis

d) Network Status Monitoring

e) Network Margin Control

f) Jammer Detection and Analysis

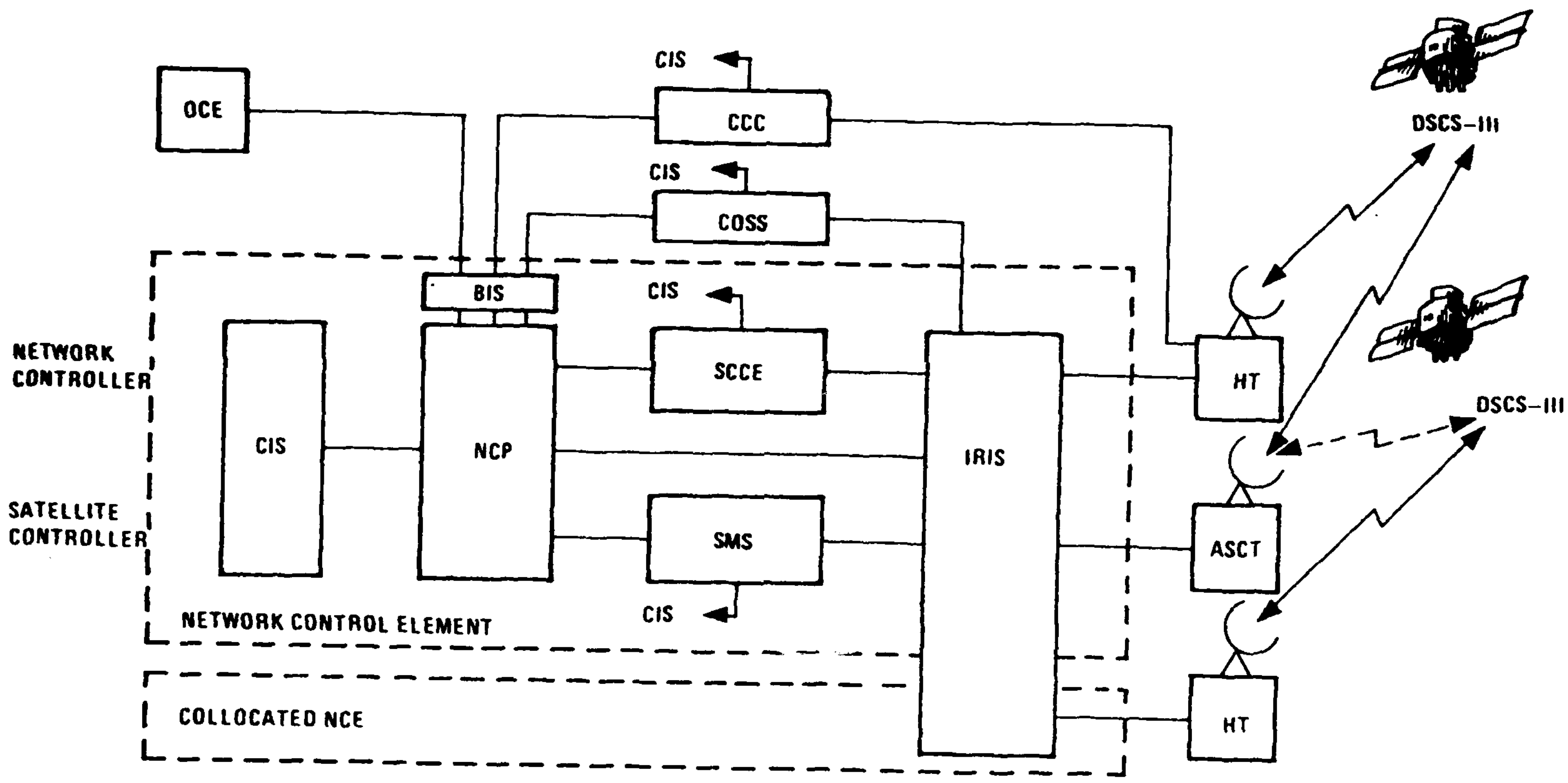
g) Data Base Management

h) Distributed Processing

The equipment included in the NCE is shown in Figure A-7. The Network Control Processor (NCP) is the central point from which the OCE acquires data and to which it sends reallocation requests. The remainder of the equipment is for operator, satellite, and TCE interface.

On-Line Spare Provisions--Because the NCE is a critical element in the overall DSCS, a back-up NCE is provided. The NCE prime and back-up stations are at eight geographically separate locations according to the latest plans. This differs from the earlier approach of having certain loations be the primary NCE for one satellite and the back-up for another.

Role of NCE Within the CS--The primary role of each of the four (plus spares) NCE's in the Control Segment is to manage and control the network of terminals associated with a particular satellite. Each satellite is expected to serve a network of up to 60 terminals; each collection of terminals is under the control of a separate NCE.



Reference 22

Figure A-7. Network Control Element System Diagram

The network of each NCE is not a stable interconnected network; on the contrary the network is intended to supply varied connections and links based on requests from the OCE controller. In fact, the network is expected to form new links within five minutes of the request for the link if the terminal equipment involved is under remote control; the time limit is considered to be 20 minutes if control of terminal equipment is manual at the time of the request.

Technique of Network Formation--Whenever a new configuration is requested by the OCE, the NCE involved must follow a very fixed set of procedures. First, the request is acknowledged via communication with the OCE functions. Second, a complete loading analysis is performed by the NCE to determine if the network will tolerate the new configuration.

If everything appears to be acceptable at this point, the Network Controller is notified and the NCE passes the information on to the OCE.

The last step is for the OCE to combine all of the other inputs to determine if the overall reconfiguration is acceptable to all NCE's involved. If this turns out to be true, the OCE issues the request for reconfiguration to all involved NCE's. The NCE's can then issue all necessary commands to implement the change and await verification. When verification of the new configuration is obtained, the NCE must properly update the data base and forward verification to the OCE. The OCE can consider the change implemented when all involved NCE's have verified the reconfiguration.

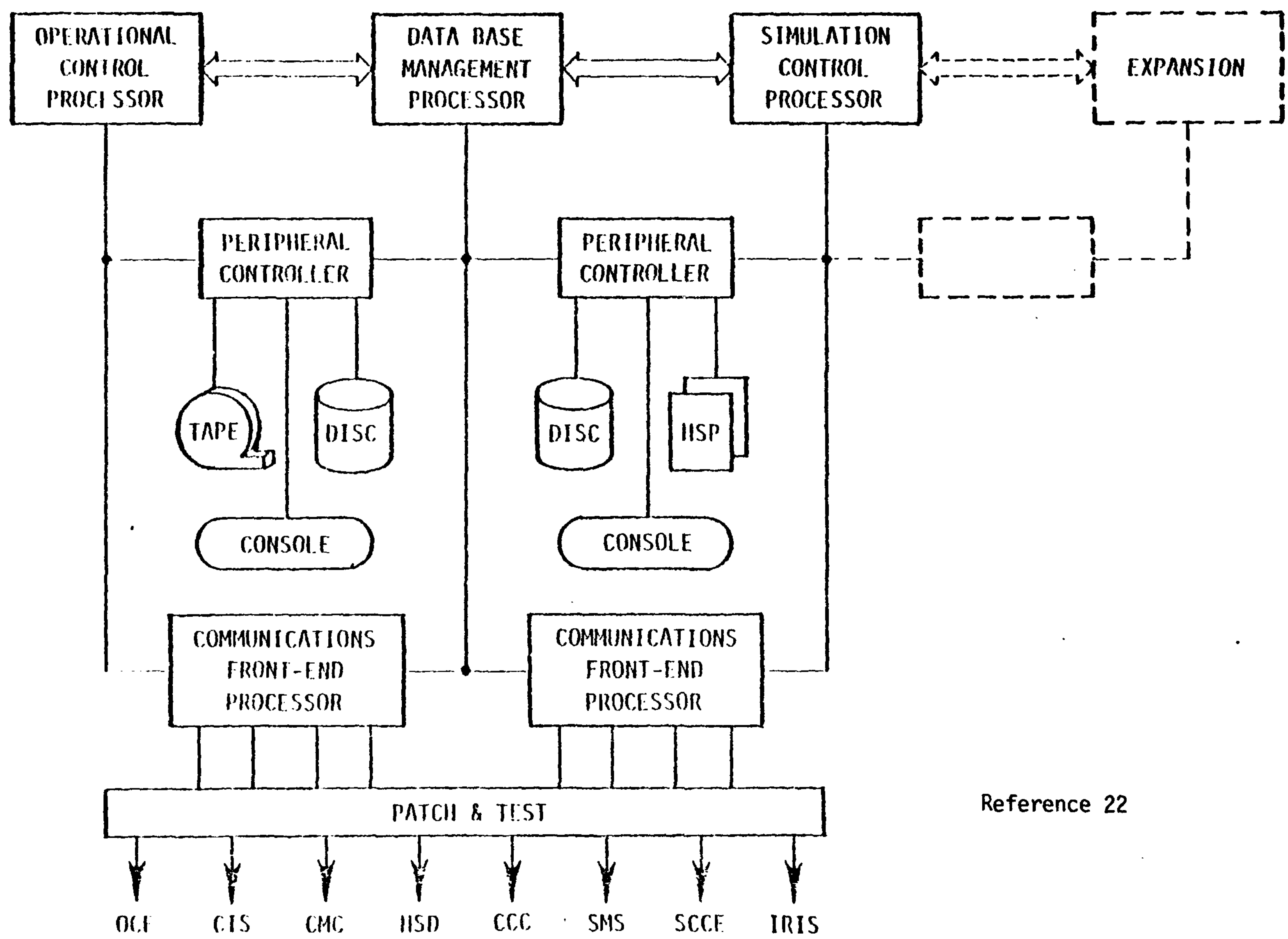
The above request-acknowledge technique is used in the overall DSCS primarily to avoid confusion and error. The entire lapsed time for the procedure is 5-20 minutes and the procedure "guarantees" that erroneous configuration will not be attempted or logged incorrectly at the OCE, NCE or TCE level.

Additional NCE Functions--In addition to forming network paths, which is by far the major role, the NCE collects, collates and passes status information for the OCE. Such status reports as jamming situation, signal characteristics at various receivers, etc., fall in this category of network monitoring and reporting.

Distributed Processing in the NCE--In virtually all areas of the DSCS, distributed processing is utilized in a fault tolerance mode. That is, the processing load is first separated and performed by multiple processors. In the event of failure of a single element, the processing load is repartitioned among those elements that remain operational and the failed unit is discontinued and disconnected for repair and/or replacement. The primary partitioning being considered in the NCE is shown in Figure A-8, taken directly from the NCE specification. In addition, it is planned to provide individual processing elements for the following:

SCCE	COSS
SMS	TCE

Characteristics of SCCE--The current specification for the SCCE is that it is a 16 bit machine with a memory cycle time of 640 NSec. In addition, the memory can now be estimated as being 256K-1024K bytes in size. This allows estimation of the overall size of the NCE as being considerable; the SCCE is only one of six similar sized processors within each NCE.



Reference 22

Figure A-8. Network Control Processor Concept

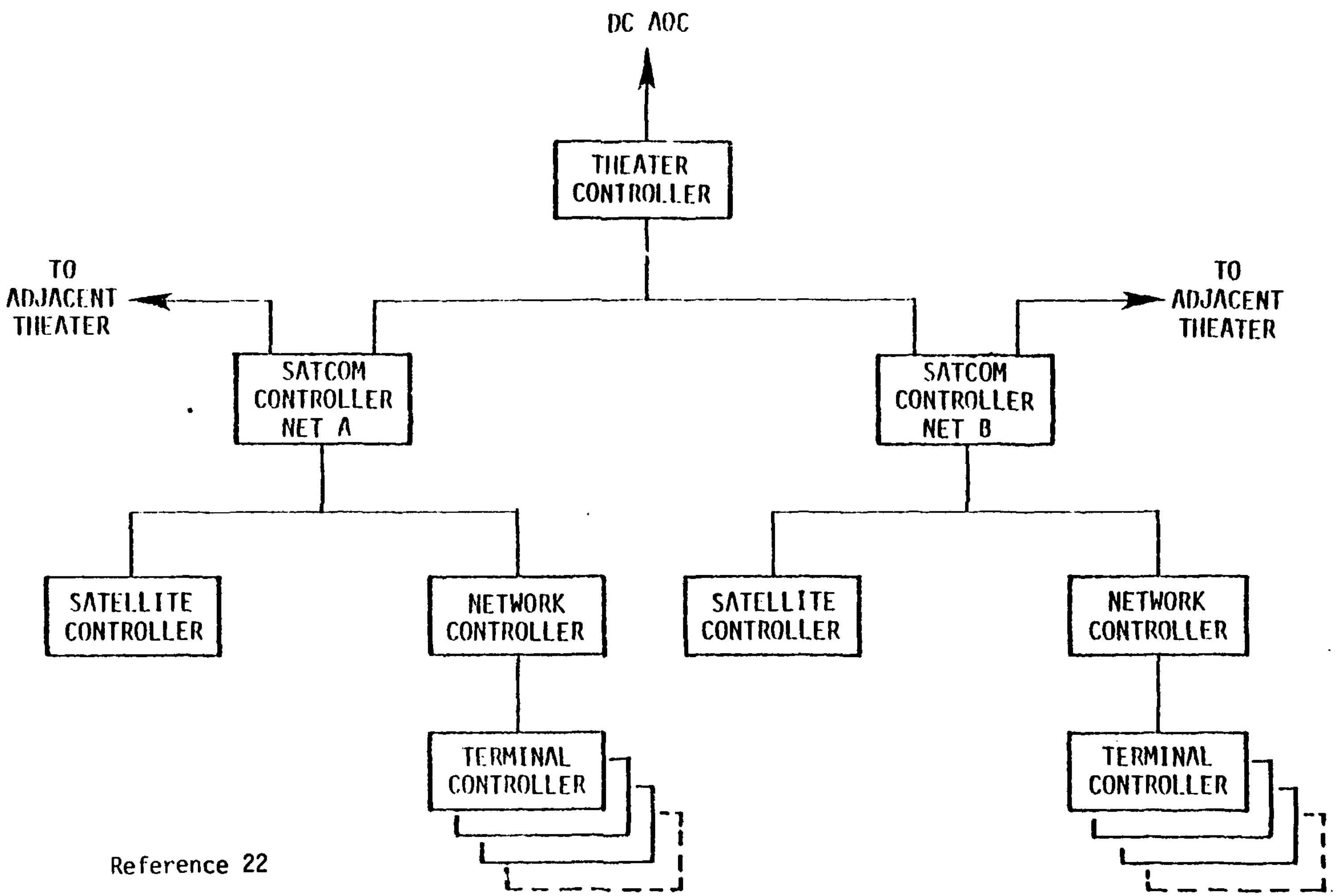
Manning of Controller Functions--In addition to the partitioning of processing, the DSCS now also partitions the various control functions. The type and reporting order now envisioned for the overall DSCS (and the NCE, in particular) is shown in Figure A-9. The interesting aspect of this particular diagram is the direct partitioning of the satellite control and network control.

Dynamic Service Types--While some of the equipment necessary for accomplishing them is still in development, the type of service planned to be offered by the DSCS NCE is now separated into static and dynamic types. The three variable types of service are discussed below.

The first type of service is referred to as Scheduled Service. This simply means that the needs are predictable. Need is expected to be 200 Kbps to 10 Mbps for 2-6 hours per day. The need is expected to be both periodic and predictable The satellite resources used are previously reserved, but are shared with other users.

The second type of new service is referred to as Dynamic Service and is expected to be 50 Kbps to 1.5 Mbps with unpredictable schedule but will require about 30 minutes of service with less than 2 hours notice. This is to be supported by a programmable device on a "single channel per carrier" basis.

The third type of service is called Priority but will require only 2.4 Kbps to 64Kbps and can be implemented for less than an hour with less than 15 minutes notice. The procedures to access the satellite network will be the same as AUTODIN II terminal and host protocols to access an AUTODIN II node.



Reference 22

Figure A-9. Organizational Structure for DSCS Control

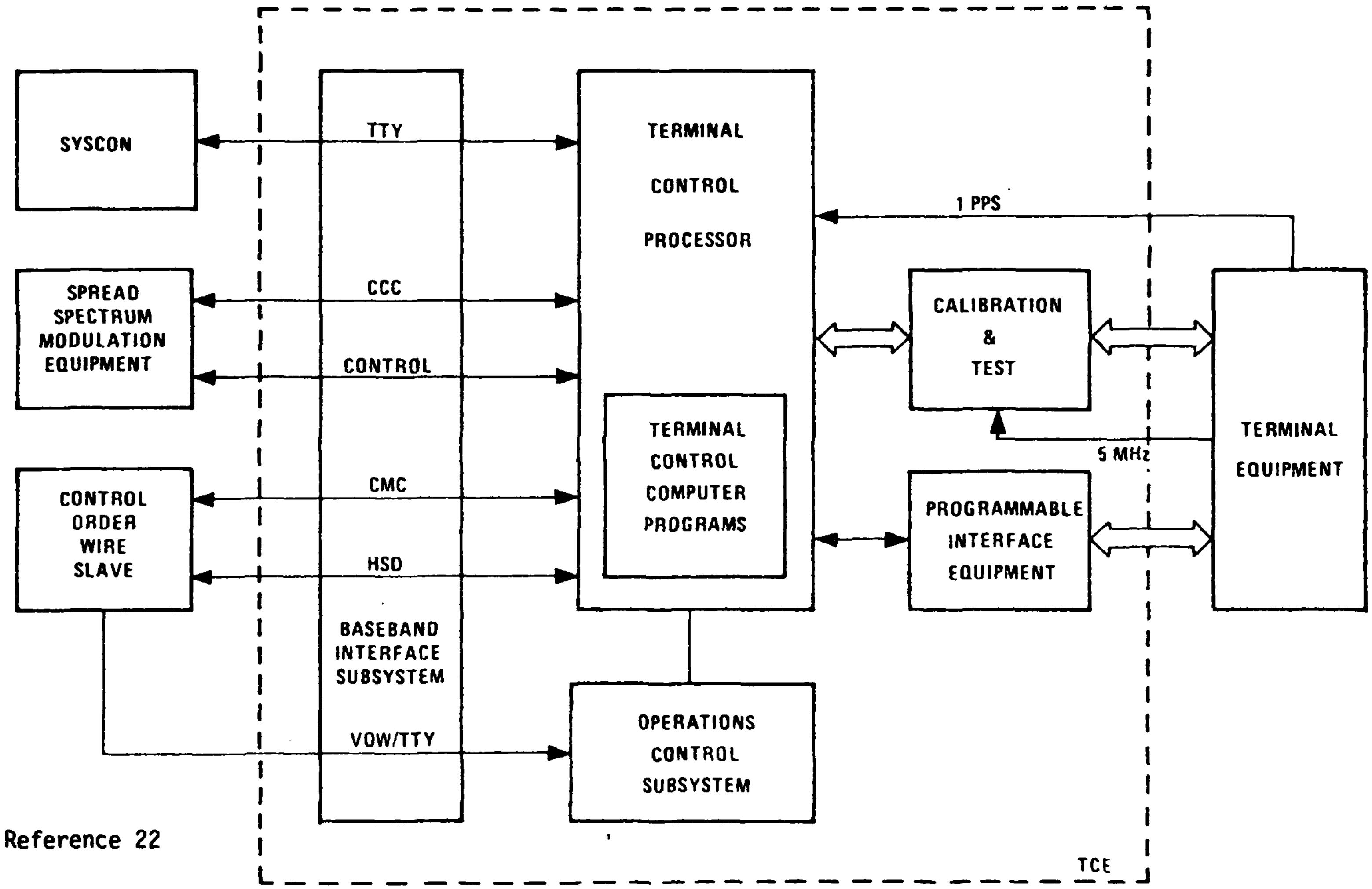
TCE Description

The TCE monitors the performance of a satellite earth terminal and assists in controlling and configuring the terminal. Four types of TCE's will be used depending on the capabilities of the Earth Terminal. See Table A-5.

TABLE A-5. TCE CHARACTERISTICS

Characteristics \ TCE Type	I	II	III	IV
Type of Terminal	Non Nodal	Non Nodal	Nodal	Net
Number of Tx Carriers	$\leq$ 4	$\leq$ 4	$\geq$ 4	$\geq$ 4
Number of Rx Carriers	$\leq$ 4	$\leq$ 4	$\geq$ 4	$\geq$ 4
AN/USC-28 (U) Interface	No	Yes	Yes	No
Hardwired NCE Interface	No	No	No	Yes
Number of Racks	1	1	2	3
Tempest Qualified	Yes	Yes	No	No

As shown in Figure A-10, the TCE consists of a number of components. The Terminal Control Processor (TCP) serves as the collection point for data acquired from the terminal subsystems, and is, therefore, the key source of data from the TCE. The interface to 'SYSCON", labeled "TTY" in the Baseband Interface Subsystem, is the port to be used for connection to the CIS.



Reference 22

Figure A-10. Terminal Control Equipment

The TCP has the following characteristics:

a) 16-bit word size

b) Direct addressing of up to 64K words

c) Main Memory of up to 500K words without chassis expansion

d) Real-time-clock with 10 milliseconds resolution

e) 16 levels of priority interrupt

f) Firmware to permit remote initialization and program loading

g) Capacity for up to 14 I/O channels without chassis expansion

h) Two levels of memory protection

i) Fault isolation and detection with diagnostics to the Line Replacement Unit (LRU)

Description of Control Orderwire Subsystem

The COSS has the following means of communication:

a) The Clear Mode Control Channel (CMC) - This net allows a single NCE to directly communicate with up to 60 Net Terminals. No security is planned for this line.

b) The Critical Control Circuit (CCC) - This allows connection to 30 TCE's via an AN/USC-28 unit. This allows encrypted communication at 75 bps.

c) NCE/TCE High Speed Data (HSD) Circuits - The NCE may be connected by 16 Kbps data lines to up to two TCE's. Set up is made via dialing.

d) NCE/TCE Text Message (TTY) Circuits - This is a one-to-one message between the NCE and a TCE. Even TCE-to-TCE messages have to go via the NCE. TCE to TCE comm is generally via the CMC.

In addition to the communication connection equipment, it is also expected that the CS will contain a dedicated processor assigned simply to the COSS function. This is still mentioned only as a possibility but it appears quite reasonable if the communication requirement expands much above that specified above.

The resident elements and their functions are shown in Figure A-11.

Distributed Processing Concept Within DSCS/CS

While the Overall Control System is rank ordered in a fashion similar to the overall ranking of the DCS, the concept of distributed processing is inherent in the design of the control system. That simply means that any processor can directly address another processor at, or even below, the level of the requestor. Pure access is to be provided for the following items within any level of the DSCS.

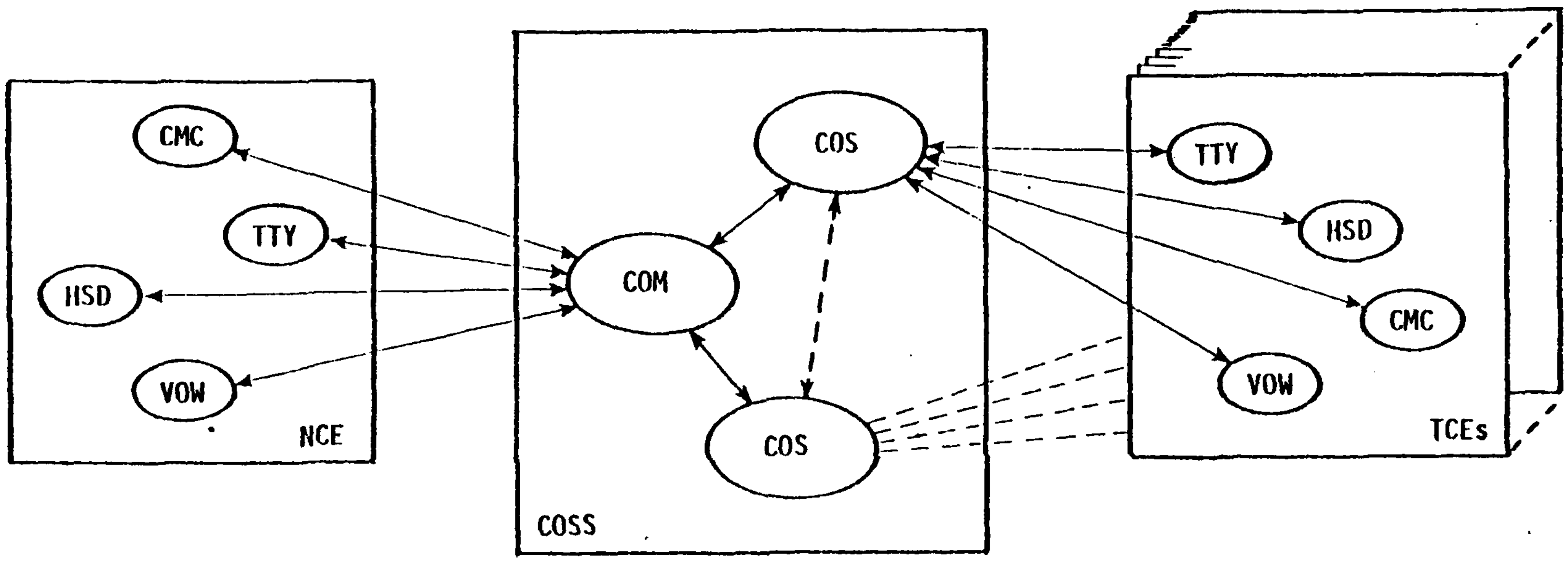
a) Data Base

b) Operational Statistics of the Unit

c) Programs

d) Direct Access to Displays

The general concept is used to avoid "single point failures" within the DSCS/CS. Should any processor or communication element fail its own periodic testing pattern, it is simple to isolate that particular element and move the responsibilities to another similar processor until the failure is repaired.



FUNCTIONS

CMC - CLEAR MODE CONTROL

VOW - VOICE ORDER WIRE

HSD - HIGH SPEED DATA

TTY - TELETYPE MESSAGE DATA

Reference 22

KEY - ELEMENTS

COSS - CONTROL ORDERWIRE SUBSYSTEM

COM - CONTROL ORDERWIRE MASTER

COS - CONTROL ORDERWIRE SLAVE

NCE - NETWORK CONTROL ELEMENT

TCE - TERMINAL CONTROL ELEMENT

——— DEDICATED CIRCUIT

– – – SWITCHED CIRCUIT

Figure A-11. Control Orderwire Network

Software Approach--The OCE is the first level where software implementation is specified for a DSCS control segment. However, the general structure of software is identical irrespective of the level of implementation (OCE, NCE, etc.) and somewhat independent of the function to be serviced by the software module.

Structured Programming--Virtually every level of software is specified for implementation via structured, top down, modular techniques. It is very difficult to avoid this concept since many of the functions have been implemented in laboratory or EDM form using top down software techniques. In all cases where a design has been formally introduced, the structure of that design is suggested by the specification as a "reasonable starting point" for further software development.

Use of the HOL--The use of a Higher Order Language (HOL) is specified at all levels of the DSCS/CS. In fact, it is generally specified to use FORTRAN whenever possible and provide comments on 75% of the software that must be implemented in assembly or machine language. As a final note, every software specification is identical in using these requirements.

A.4 CHARACTERIZATION OF ATEC

The ATEC system, as specified by the ATEC 10000 Specification, (Reference 2), is structured to support the management and control levels of the DCS System Control Hierarchy (SYSCON) as shown in Figure A-12.

In actual application, the ATEC System provides automated support to the sector, nodal and station levels in those performance assessment and status monitoring functions primarily related to maintaining the DCS transmission

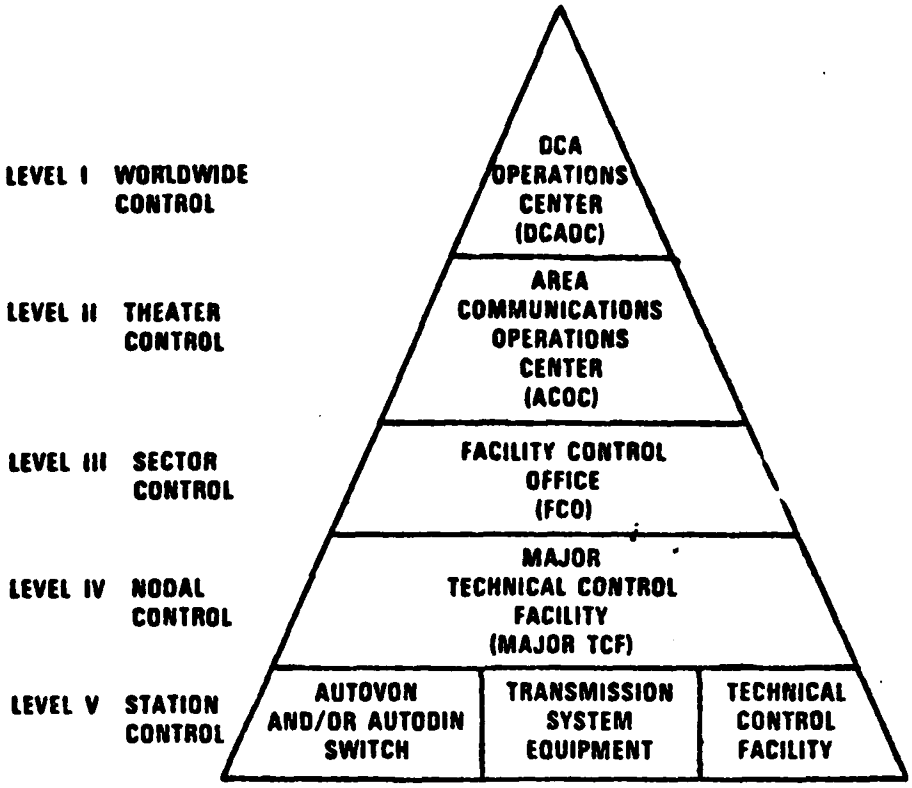


Figure A-12. DCS System Control Hierarchy facilities. ATEC is specified to include capabilities to implement requirements allocated to it in support of the upgrade of DCS SYSCON. Basically, the ATEC mission is to provide the following:

- o Circuit performance assessment
- o Transmission system performance assessment
- o Equipment status monitoring
- o Detection of out-of-tolerance conditions
- o Automation of fault isolation activities
- o Automation of quality control activities
- o Centralized system status displays
- o Storage of routing plans and records
- o Automated assistance in report preparation
- o Remote control of station equipment

Functional requirements assigned to the Sector, Node and Station levels are as follows:

Sector Control Functional Area--The sector is responsible for the following:

- o Maintenance of the ATEC system data base to include DCS connectivity, ATEC connectivity, ATEC to DCS connectivity, and performance measures.
- o Collection of status information and assessment of the quality of service and the utilization of equipment within the jurisdication of an FCO.
- o Preparation and submission of formal DCA reports.

- o Coordination between FCO's and between nodes within the jurisdication of an FCO.
- o Preparation of transmission system alternate route actions and coordination of their implementation.
- o Provision for processing assets and interfaces for evolving SYSCON capabilities.

Nodal Control Function Area--The node is responsible for the following:

- o Direction and control of all ATEC station control equipments subordinate to a major TCF.
- o Correlation of parameter measurements and status indications, identifying degradation and isolating faults.
- o Transmission of status information to the sector control functional area.
- o Coordination of interstation testing and measuring activities.
- o Direction and coordination of circuit-level alternate route actions within the jurisdiction of a major TCF.
- o Maintenance of the ATEC System data base within the jurisdication of a major TCF.
- o Provision for processing assets and interfaces for evolving SYSCON capabilities.

Station Control Functional Area--The station is responsible for the following:

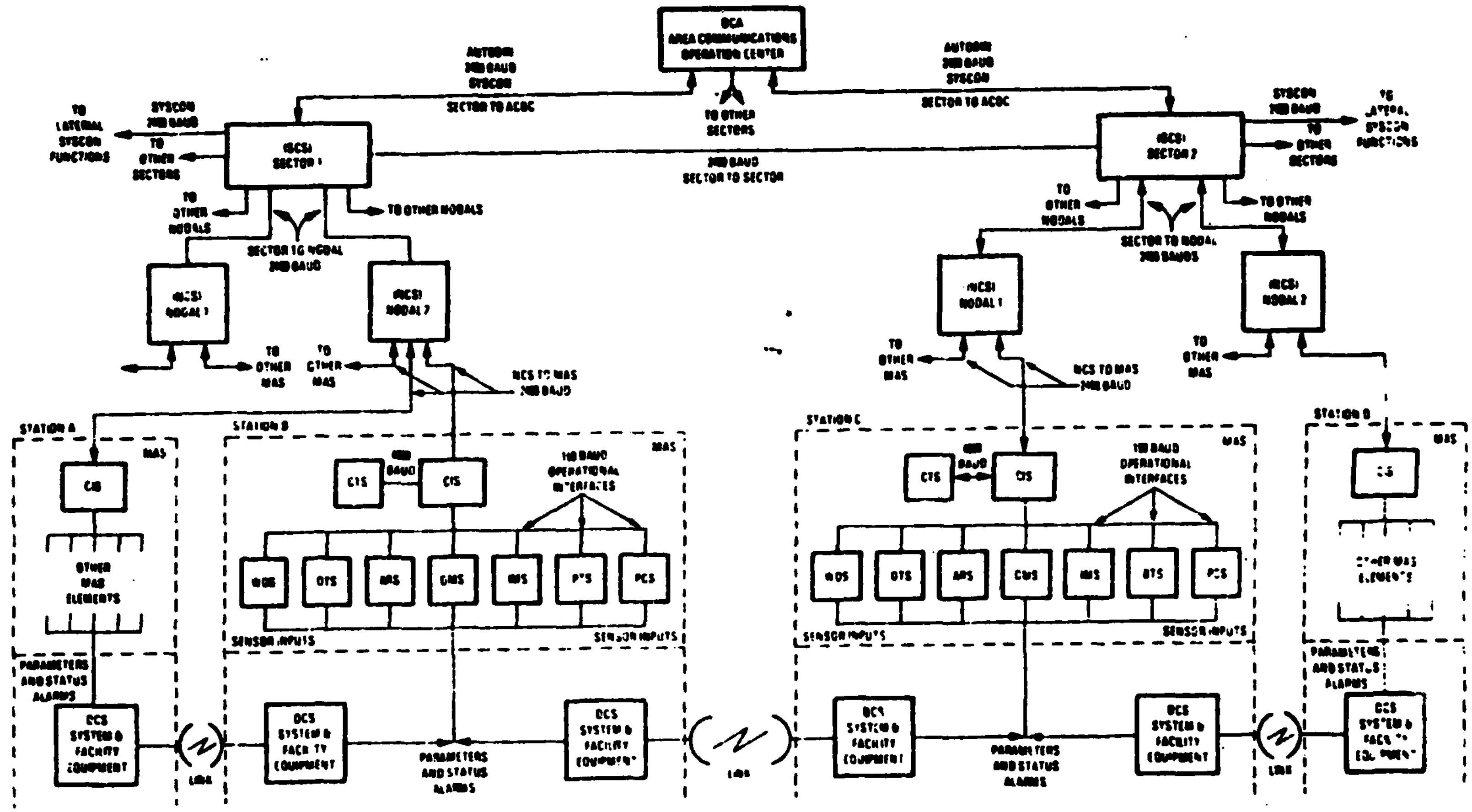
- o In-service monitoring of voice frequency (VF) circuits, DC circuits, frequency-division-multiplexed (FD) baseband signals, and time-division-multiplexed (TDM) wideband digital transmission signals.

- Detection of out-of-tolerance signal conditions and alarming.
- In-service parameter measurement acquisition.
- Test signal injection and parameter measurements based on the test signals.
- Collection and reporting of equipment and facility alarms.
- Provision for an interface to the nodal control functional area.
- Provision for a local station level interface between technical controllers and the measurement acquisition and monitoring functions.
- Transmission of exception and status information to the nodal control functional area.
- Provision for control of ATEC station level equipments from a remote location.

ATEC System Internal Interfaces

The ATEC System interconnections are shown in Figure A-13. The interfaces are discussed in more detail in the "Interface" section below. The hierarchial relationships and functional deployment concepts are as follows:

Theatre Control Level--As currently envisioned by the government, a theatre control area (such as Europe, Pacific, etc.), can contain a maximum of up to five Sector Control Subsystems (SCS). Each SCS interfaces with the DCA Area Communications Operations Center (ACOC) for that theatre via AUTODIN. In addition to ACOC, this interface is used as the Military Departments's (MIL DEP)



Reference 2

Figure A-13. General ATEC System Functional Flow interface. The sectors interface laterally with each other sector in a given theatre. Interfaces with other NON-ATEC, SYSCON related inputs will also be provided at each SCS.

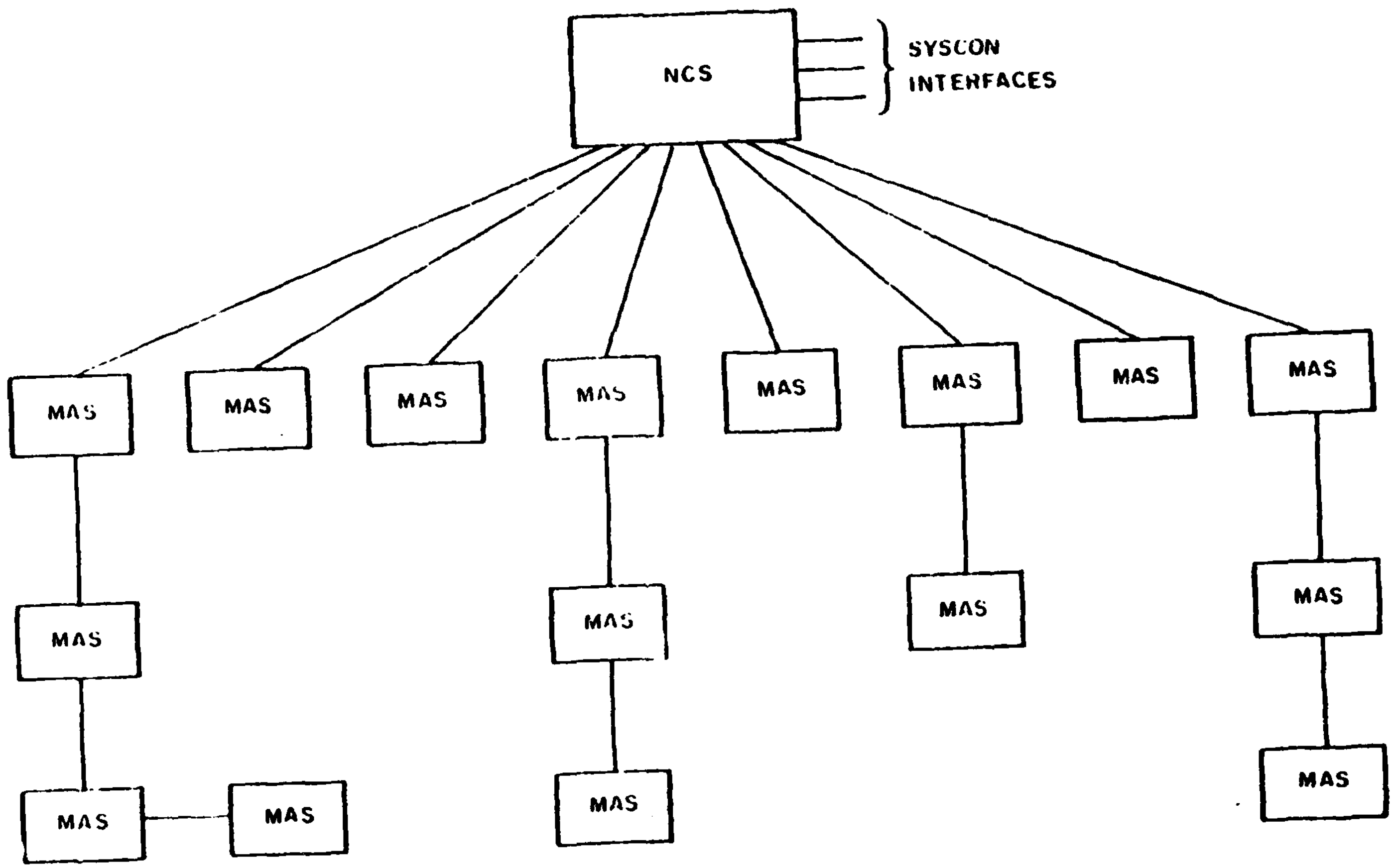
Sector Control Level--The current specified Sector control subsystem can control up to five Nodal Control Subsystems (NCS). Each NCS interfaces with the SCS for that sector. The NCS has the capability to interface with other NON-ATEC, SYSCON related inputs. Lateral communications between nodals is provided by the SCS.

Nodal Control Level--As currently specified, up to a maximum of sixteen Measurement Acquisition Subsystems (MAS), can be connected in a combination single and multipoint configuration. The NCS will facilitate eight single point MAS interfaces. An additional eight MASs may be deployed in a multipoint arrangement (functioning under a single point MAS) as shown in Figure A-14. Lateral communications between MASs located at manned technical control facilities is provided by the NCS.

Components of Each ATEC Level

The components, both hardware and software, which comprise the ATEC sector and node are discussed in the following subsections. Note that referenced sections of the ATEC 10000 specification, Volume 1, are included at the end of this subsection.

Sector Control Subsystem (SCS)--The SCS is located at an upper level of the ATEC-LRIP System Hierarchy where it interfaces upward with the Area Communications Operations Center (ACOC) and Military Departments (MIL DEPS), laterally with other SCSs, and downward to Nodal Control Subsystems (NCS). From this position

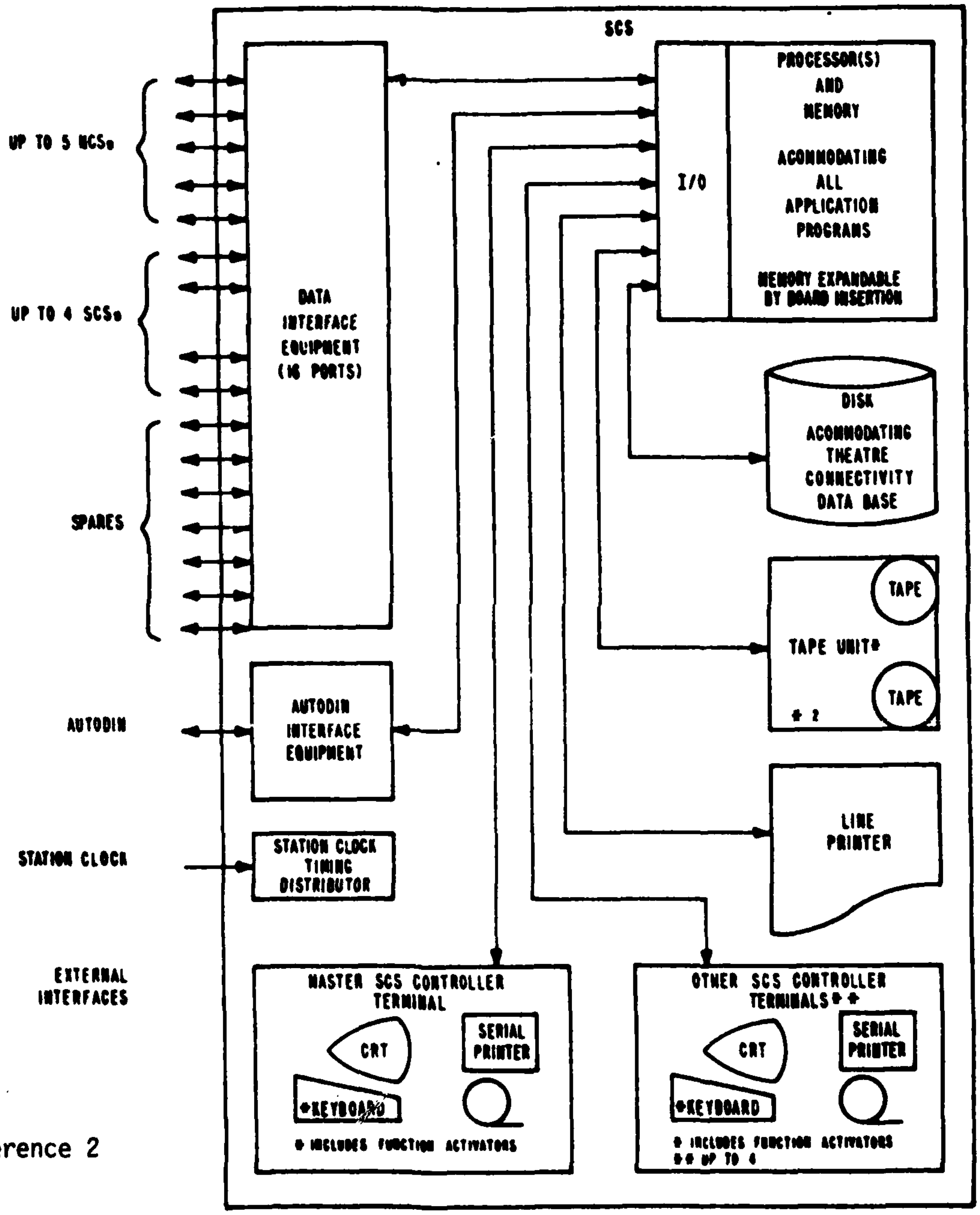


Reference 2

Figure 4-14. Nodal Control Level Layout

in the hierarchy it is necessary for the SCS to store the data base information for the theatre and update various subsystems. The SCS is a record keeper, a report generator, a participant in the fault isolation process and is involved in the altrouting and restoral process. Additional requirements will be added as the evolving Defense Communications System (DCS) adds System Control (SYSCON). These and other related activities require that the DCS also provide displays and an excellent man-machine interface.

As shown in Figure A-15, the SCS is the set of equipments and programs at the FCO (Sector) level of the DCS hierarchy that processes communications from adjacent SCSs, subordinate NCSs, and the sector's controlling ACOC. Based on these communications and sector controller actions, the SCS maintains a theatre connectivity data base, current status indications of sector-associated facilities, restoral and alternate route plans, and parameter history files; and, it passes responsibility and data necessary to continue a fault isolation or performance assessment from one of its nodes to another, or to an adjacent sector, or from an adjacent sector to one of its nodes. The SCS, as the result of controller action, interrogates, displays and modifies selected portions of its files relating to connectivity data, alternate routes, facilities, parameter histories and event logs. It displays preformatted reports, entries to which are controlled by the sector controller. It allows controller entry of free-form messages. It automatically displays all messages, directions and fault isolation conclusions received from other ATEC elements requiring controller attention. It directs the printing and transmission of any display. All significant events at the SCS are entered in the event log.



Reference 2

Figure A-15. General SCS Equipment Configuration

SCS Major Components--As specified, the SCS shall consist of the equipments necessary for ATEC operation at the FCO level as described below. Figure illustrates a possible configuration of the SCS equipments. The SCS is considered as a single component. For ease of understanding, the characteristics of the SCS will be described, when necessary, in terms of the components listed below.

1) Processing Equipment and Growth Provision. The SCS configuration shall contain a processor or processors having access of high speed memory that shall have sufficient capacity to accommodate ATEC function processing needs and all of the physical characteristics requirements of 3.2.2 of the 10000 spec. It will also accommodate growth requirements. The processor will have an initial high speed memory configuration equivalent to no less than 58,000, equivalent 16 bit words. The direct memory access rate will be no less than 1 million bytes per second. The combination of processor or processors and high speed memory will hereafter be referred to as the processing equipment or computer.

2) Disk Drive Equipment. The SCS will contain disk drive equipment, employing replaceable media, interfaced with the computer. The disk drive equipment will have an on-line disk capacity capable of accommodating an entire DCS theatre connectivity data base and those on-line application and application support programs that cannot be accommodated in high speed memory. Removable media that can be stored off-line will also be the means by which support programs, back-up storage of application progams, and back-up storage of data base shall be supported. The SCS data base and programs will be loadable at the SCS and shall be operational within 15 minutes of load initiation.

3) Tape Drive Equipment. The SCS sahll contain a minimum of two, nine track tape drives interfaced with the computer. Tape shall also serve as alternative backup for storage of data and programs and the tape drives shall be capable of being used as loading devices. Nine track tape shall satisfy ANSI X3.22 1973, FIPS 3-1, and shall operate at a data rate of at least 20,000 characters per second.

4) Terminal Equipment. The SCS will contain up to five sector controller terminals, interfaced with the computer, one of which will be designated the master sector controller terminal.

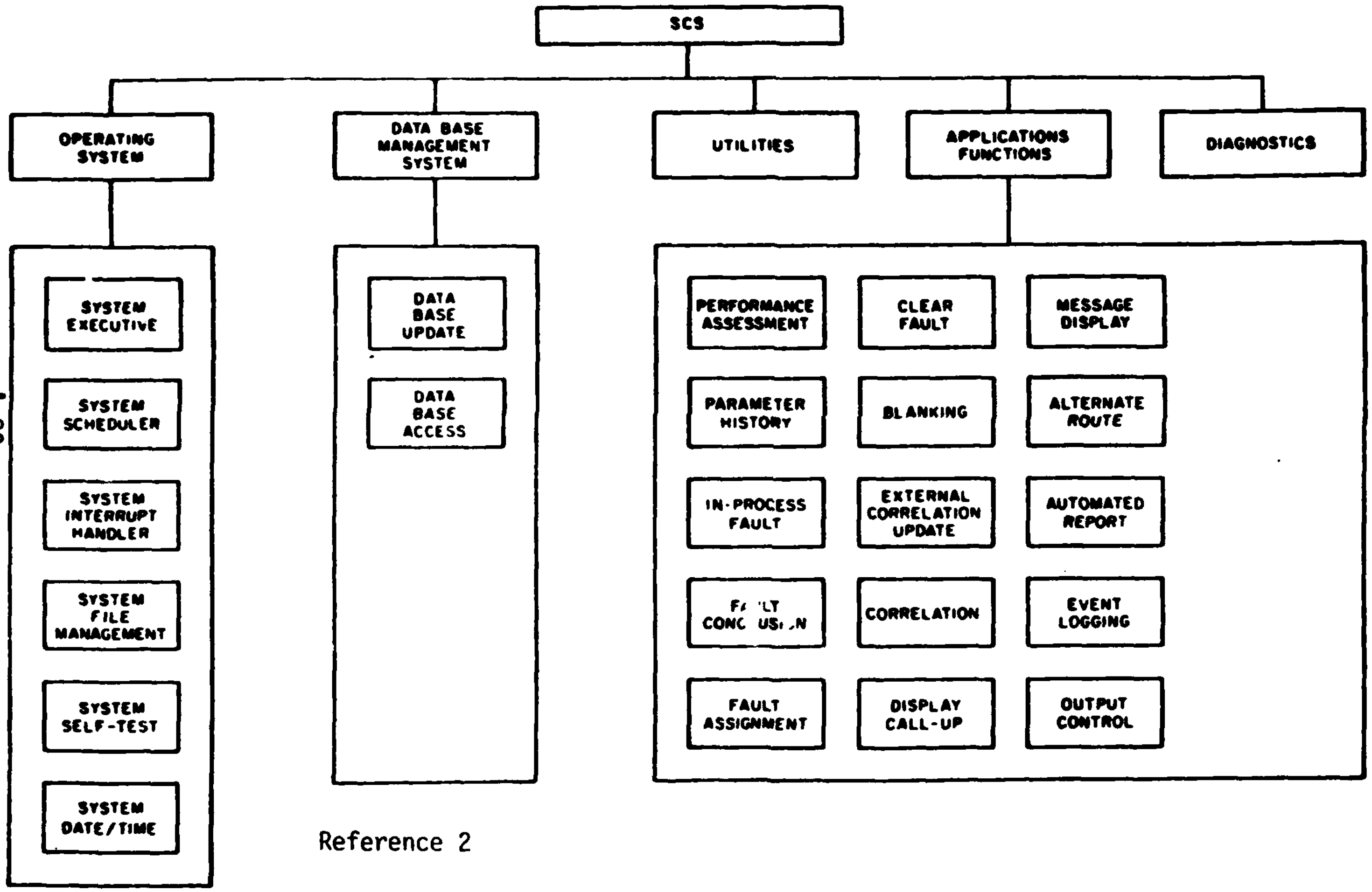
5) Line Printer Equipment. The SCS will contain at least one impact line printer, interfaced with the computer, capable of printing a minimum of 300 lines per minute for the prime purpose of providing hard copies of data base information.

6) Data Interface Equipment (DIE). The SCS will contain a DIE, interfaced with the computer, capable of transmitting and receiving messages via 2400 baud communications ports. Ports will permit interfacing via appropriate external devices (such as data modems) and dedicated lines with up to four adjacent SCS's, and five subordinate NCS's. Sever spare ports, to accommodate SYSCON requirements, will be included in the DIE.

7) AUTODIN Interface Equipment (AIE). The SCS will contain an AIE, interfaced with the computer, capable of transmitting and receiving messages via AUTODIN.

SCS Software Functional Characteristics

Figure A-16 depicts the SCS software requirements. The operating system performance

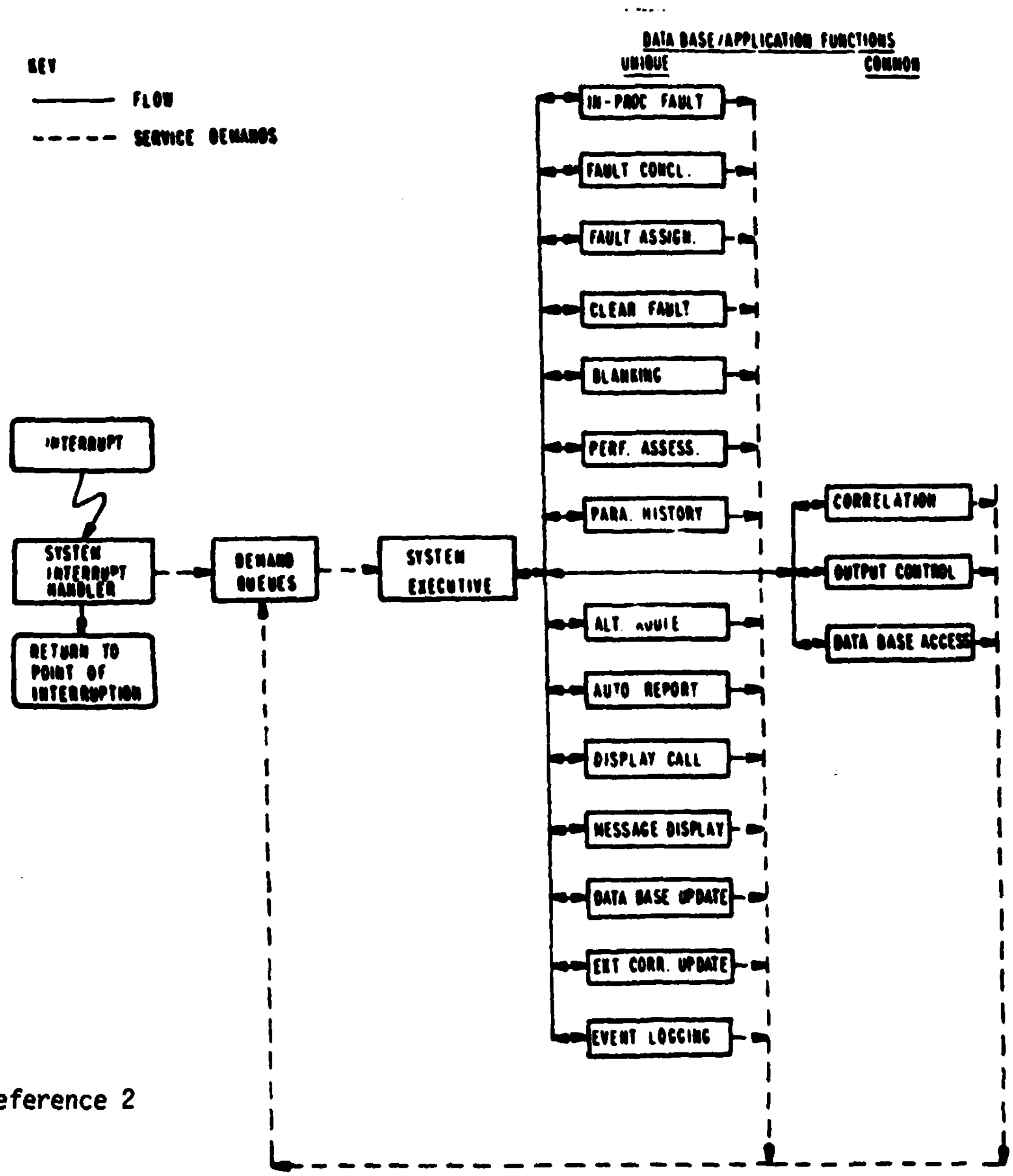


Reference 2

Figure A-16. Sector Control Subsystem Software characteristics are as described in the following subsection. The utilities and diagnostics indicated in Figure A-16 shall be provided in accordance with 3.3.8 of the 10000 spec. Figure A-17 indicates program actions controlled by interrupts and program action controlled by the executive. The service demand lines indicate the sources of service demands and indicate execution access to demand queues to determine the next function to be executed. The design of the hardware and software of the SCS processor equipment, while it shall incorporate all of the functions and capabilities indicated in Figures A-16 and A-17, does not preclude the addition of other functions.

1) Operating System Performance Characteristics. An operating system tailored to SCS hardware and application requirements may be generated from an existing operating system capability. Only those modules required by the application requirements will be incorporated into the operating system. The operating system contains real-time and disk support features. The major functions to be included in the operating system are described in the following subsections.

a) System Executive. The system executive controls the allocation of resources such as main memory, processor timing, input/output, and mass storage. It also handles communications between application program modules and the operating system. In support of this function, main memory will be mapped into areas, to support resident portions of the operating system, resident application program modules (as applicable) and a multiple-use area for non-resident operating system or application program modules. The multiple-use area shall support multiple memory partitions allowing more than one non-resident program module to be present in main memory at a time, so that the switching execution



Reference 2

Figure A-17. Control of the SCS Processor Functions from one program module to another can be accomplished in main memory when practical. The system executive is supported by an appropriate routine to select messages or requests to be processed, and assign control to the proper data base or application function. When this function is normally entered, the highest priority demand queue will be examined for the presence of an entry. If none exists, the next highest priority demand queue will be examined for entry. If no entries are found in any of the demand queues, a self-test will be performed and control will again return to this function at the normal entry point. When an entry is found, the message or request will be extracted from the queue, its message type will be determined, and the appropriate function will be called and presented with the message extracted from the queue. When the called function has completed or suspended its tasks, it will return control to the executive function at the normal return point. Called functions may add messages or requests to the demand queues. In general, an application program module calls the system executuve of the operating system to:

- Perform I/O operations.
- Allocate and release disk space.
- Suspend or terminate itself.
- Schedule other program modules for execution.
- Set time of execution cycles.
- Obtain partition status information.
- Obtain the current time from the real-time clock.

o Load a background disk resident program segment.

b) System Scheduler. the system scheduler shall organize and schedule application program modules for execution. It shall include the activation, termination, suspension and preparation of application program modules for execution. Scheduling of application program modules shall be based on demands for particular modules and the assigned priorities of the modules.

c) System Interrupt Handler. The system interrupt handler shall allow the computer to recognize the occurrence of an asynchronous external event. The processor shall service that event utilizing transfer vectors and interrupt priorities and levels. When an interrupt is recognized, processor control shall be transferred to an interrupt processing routine. The operating system shall maintain queues for the use of I/O devices and shall overlap I/O operations with processing. The I/O control function shall set up and schedule the operations necessary to perform requested I/O actions, shall transfer data from main memory to I/O devices or mass storage, or from I/O devices or mass storage to main memory. The system interrupt handler shall be supported by appropriate routines such that when a complete message or request has been received, it shall be placed in the appropriate priority demand queue for scheduling actions.

d) System File Management. System file management shall include file management and I/O support. File management shall provide for the creation of new data files and the modification or elimination of existing files. This function shall permit file organization on disk to be specified to be either contiguous (fixed length) or non-contiguous (dynamically allocated). It shall also permit multiple logical records for sequential and relative record file I/O to be blocked into physical records to minimize access time. I/O support shall provide for uniform and consistent access to the I/O devices by the application program modules.

e) System Start-Up and Recovery. The operating system shall support system start-up and recovery routines which shall provide the features specified in 3.2.1.13 of the 10000 spec.

f) System Self-Test. The system self-test shall provide processor and memory error-checking and I/O device integrity-checking on a non-interferring, background basis. It shall also identify appropriate error and abnormal state conditions or indications reflecting conditions requiring controller attention. A condition such as illegal or incomplete commands and device time-outs shall result in an appropriate error condition message.

g) System Clock. The operating system shall maintain a real-time clock that shall be accessible upon demand. Current time shall be updated at a minimum of once per second and shall be maintained in terms of hours, minutes, and seconds. When a station clock is avaiable, the real-time clock will be driven by means of the station clock interface as described in 3.1.5.1.4.3. The real-time clock shall support a routine that shall establish, maintain and propagate date and time in accordance with 3.2.1.15. This data and time shall also be available for insertion into message headers.

2) <u>Data Base Performance Characteristics</u>. The data base performance requirements are specified in the ATEC 10000 specification, Paragraph 3.2.1.12. Guidance documents referenced by the specification are listed as follows:

a) Technical Description, Data Base for the ATEC Site Nodal Controller Subsystem, TD-4952-750, September, 1977.

b) Technical Description, Data Base Update Package for the ATEC Site Nodal Controller Subsystem, TD-4978-800, September, 1977.

c) Technical Description, Data Base Update Control Module for the ATEC Site Nodal Controller Subsystem, TD-4978-810, September, 1977.

d) Technical Description, Data Base Update CCSD Connectivity Administration Module for the ATEC Site Nodal Controller Subsystem, TD-4978-820, (2 volumes), September, 1977.

e) Technical Description, Data Base Update DCS Trunk Connectivity Administration Module for the ATEC Site Nodal Controller Subsystem, TD-4978-830, September, 1977.

f) Technical Description, Data Base Update Site Nodal Controller Administration Module for the ATEC Site Nodal Controller Subsystem, TD-4978-840, September, 1977.

g) Technical Description, Data Base Update Scanner Administration Module for the ATEC Site Nodal Controller Subsystem, TD-4978-850, September, 1977.

h) Technical Description, Data Base Update Data Administration Module for the ATEC Site Nodal Controller Subsystem, TD-4978-860, Sept. 1977.

Growth and Spare Requirements -- The implementation of the SCS will include the capability to satisfy the growth and spare requirements specified by the ATEC 10000 specification, paragraph 10.3.3. The spare capacities will be provided in the basic SCS configuration. Growth shall be attainable through application of the same standard procedures utilized to attain the basic SCS configuration which, for example, may involve the interconnection of additional hardware. Growth shall be attainable in blocks or units which are readily separable from the basic SCS assets. Growth and spare requirements are contained in the following subsections:

1) Interface Spare Requirements. The SCS is provided with seven spare 2400 baud ports which are physically identical to the SCS/SCS and SCS/NCS ports. The standard protocol will be applied to these ports.

2) Processing Growth and Spare Requirements. The implementation of the SCS shall make provision for attaining the growth and spare capacities of primary memory, secondary memory, and processing power as specified in the following subsections.

a) Spare Processing Requirements. The processor (s) used at the sector, node and in the station level controller terminal set shall include a spare memory capacity of both primary and secondary storage, and a spare processing capacity. The spare memory capacity, measured in terms of unused character storage, and spare processing capacity, measured in terms of available processing time, shall be at least 25% of the storage and processing required for sustained operation of the system at the rates specified in 3.2.6.

b) <u>Growth Processing Requirements</u>. The processor (s) used at the sector and node shall allow a future growth of memory and processing capacity beyond that specified above as spare. The growth shall permit the later addition of the evolving SYSCON capabilities. The memory and/or processing growth requirements may be accommodated by including the growth capacities as additional spare capacity beyond that specified in 3.2.2.8.1.

c) <u>Processor Growth Requirements</u>. Paragraph 10.3.3.2.2.1 of the ATEC 10000 specification requires that the SCS processor (s) shall permit a future growth of 40,960 equivalent 16 bit words of primary memory, and three million bytes of secondary storage.

This includes, first, the capability to execute an additional ten tasks per five seconds. A task is defined to require 12,000 machine cycles and three accesses to secondary memory for the transfer of data blocks comprised of 2,000 16-bit words to or from primary memory plus two additional, identical, accesses for application programs, if they are not all resident in primary memory. The 2,000 word data blocks are assumed to be contiguous and obtainable without interruption from other tasks. The mean time allowed from the arrival at a port of the SCS of the stimulus for each of these tasks to execution completion is two seconds, and the three sigma point is not to exceed five seconds. For the purpose of this specification, the task arrival distribution is defined as Poisson.

The second growth requirement for processing power allows for the capacity to transfer additional message through the SCS, utilizing it as a message switch. This included distinct message types arriving via the communications link interconnecting a subordinate NCS and also via implemented spare ports where those messages are destined for another of the 2400 baud spare ports or the AUTODIN port provided at the SCS. Also included are the messages arriving from the AUTODIN port provided at the SCS and destined for one of the spare ports or an interconnecting communications link to a subordinate NCS. These ports are illustrated in Figure A-15. For the defined growth load of messages traversing the SCS, the processing impact on the SCS of the message switching function is to be such as not to degrade the capability of the SCS to satisfy the other processing requirements. The subject messages are defined for purposes of this capacity specification as full 80 character messages with a Poisson arrival distribution. The capability to effect the transfer of these messages is defined as an extension of the basic SCS message transfer capability and, therefore, imposes no additional, distinguishable, functional requirements on the SCS in support of the growth message processing requirement. The growth message switching capacity for the SCS spare ports shall be:

- 80% mean utilization on one 2400 baud spare port with evenly distributed destinations among the other spare ports and NCS ports.

- 20% mean utilization on three 2400 baud spare ports with a destination of the port identified in ((1)), above.

- 5% mean utilization on three 2400 baud spare ports with a destination of the port identified in ((1)), above.

d) SYSCON Functions -- It is apparent that the SCS possesses the necessary communications and processing growth potential to be a key SYSCON

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SYSTEM CONTROL FOR THE TRANSITIONAL DCS. APPENDICES.(U)
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interface point. Its position in the ATEC hierachy allows it to direct and receive transmission system parameter measurements over a large geographical area, including requests to lateral Sectors, while possessing the entire theater data base.

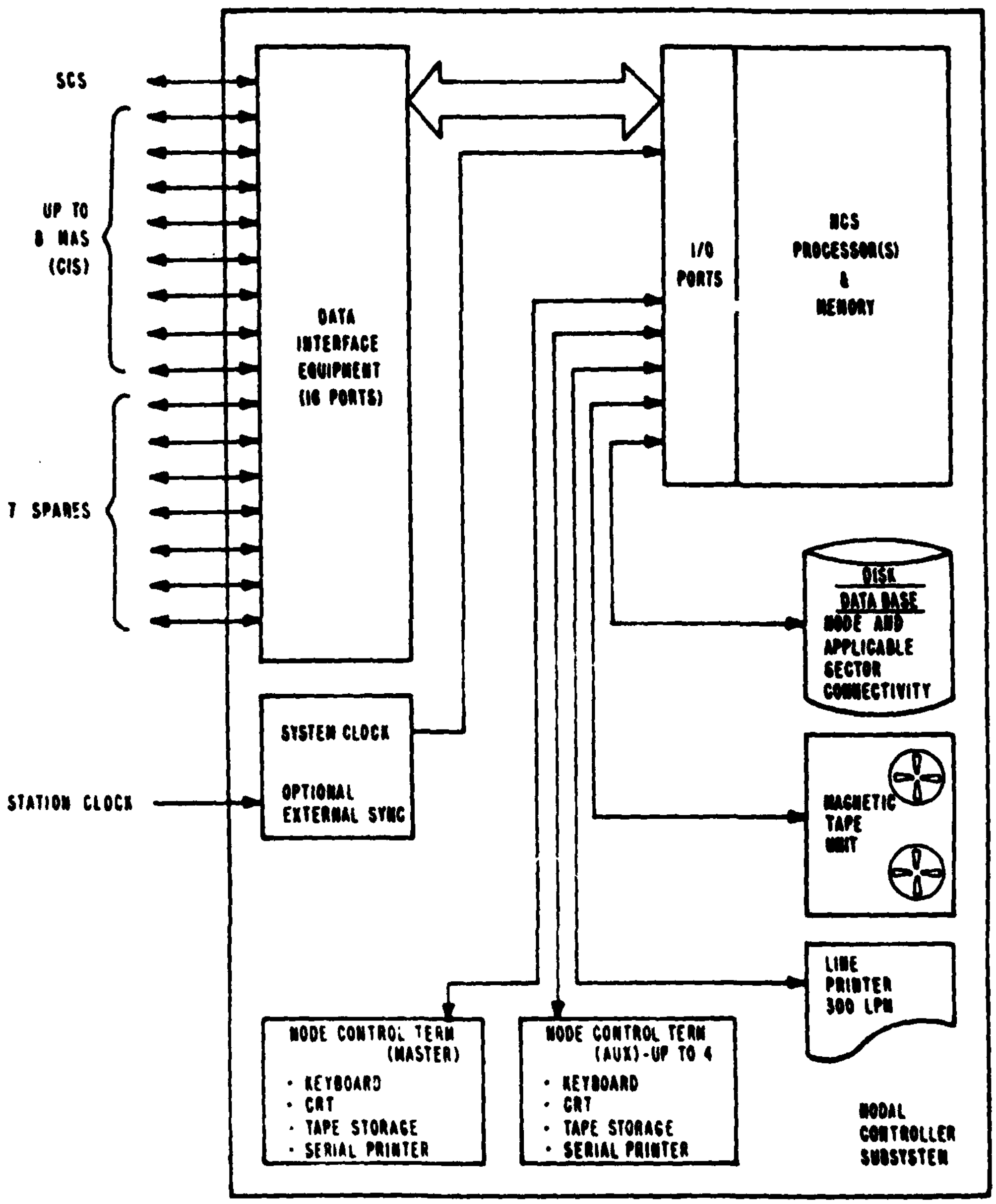
Nodal Control Subsystem (NCS) -- The NCS is at the hub of ATEC system activity, commanding actions by subordinate station equipment, collecting data, and reporting the state of the Defense Communications Subsystem (DCS) to higher management levels, and coordinating activities among adjacent NCS. The NCS is the focal point of performance assessment and fault isolation actions, being the point at which algorithms are executed. This activity requires efficient data base maintenance, rapid access to a large quantity of stored programs, quick reaction to dynamic system conditions, capability to function as a message switch, and ability to expand with a growing DCS.

The NCS functional operation includes the processing of stimulus communication from its controlling SCS and from its subordinate station-level Measurement Acquisition Subsystem (MASs) as well as generation of response outputs to these stimuli. Based on these communications and the man-machine interface inputs from the nodal controller, the NCS performs the following functions: direction and control of all ATEC station control equipments subordinate to a major Technical Control Facility (TCF); correlation of parameter measurements and status indications, identifying performance degradation and isolating faults; transmission of status information to the SCS; coordination of interstation testing and measuring activities; direction and coordination of circuit level alternate route actions within the jurisdiction of a major TCF. In addition, the NCS has growth provision for processing evolving SYSCON capabilities.

As shown in Figure A-18, the NCS is the set of equipments and programs at the major TCF (nodal) level of the DCS hierarchy that processes communications from its controlling SCS, and its subordinate station-level MASs. The NCS maintains the DCS and ATEC connectivity information pertaining to facilities within its sector's boundaries. The NCS maintains a current status file of communications facilities in its area to facilitate restoral and ālternate routing. The NCS automatically performs fault isolation to determine the location of a detected failure, and, if successful, notifies the nodal controller of its conclusions. If the NCS, in its search for the solution, reaches its boundary and is still unsuccessful, it automatically forwards information, containing the details of its fault isolation efforts thus far, via the SCS, to the NCS responsible for the adjacent station across that boundary. The NCS performs FDM multiplex alignment verification at stations which are so equipped. The NCS maintains current status files on all MAS equipments. All significant events at the NCS are entered on the event log.

Major Component List -- As specified, the NCS consists of the equipments necessary for ATEC operation at a major TCF as described below. Figure A-18 illustrates a possible configuration of the NCS equipments. These are discussed below.

1) Processing Equipment and Growth Provision. The NCS configuration contains a processor or processors having access to high speed memory that have sufficient capacity to accommodate ATEC function processing needs and all of the physical characteristics requirements of 3.2.2. It



Reference 2

Figure A-18. General NCS Equipment Configuration also accommodates growth requirements. Based on an analysis performed on an internal program, the processor requires an initial high speed memory configuration equivalent to no less than 58,000, equivalent 16 bit words. The disk memory access rate will be no less than 1 million bytes per second. The combination of processor or processors and high speed memory will hereafter be referred to as the processing equipment or computer.

2) Disk Drive Equipment. The NCS will contain disk drive equipment, employing replaceable media, interfaced with the computer. The disk drive equipment will have an on-line disk capacity capable of accommodating an entire DCS sector connectivity data base and those on-line application and application support programs that cannot be accommodated in high speed memory. Removable media that can be stored off-line will also be the means by which support programs, backup storage of application programs, and backup storage of data base shall be supported. The NCS data base and programs will be loadable at the NCS and shall be operational within 15 minutes of load initiation.

3) Tape Drive Equipment. The NCS contains a minimum of two, nine track tape drives interfaced with the computer. Tape also serves as backup for storage of data and programs and the tape drives shall be capable of being used as loading devices. Nine track tapes will satisfy ANSI X3.22 1973, FIPS 3-1 and will operate at a data rate of at least 20,000 characters per second.

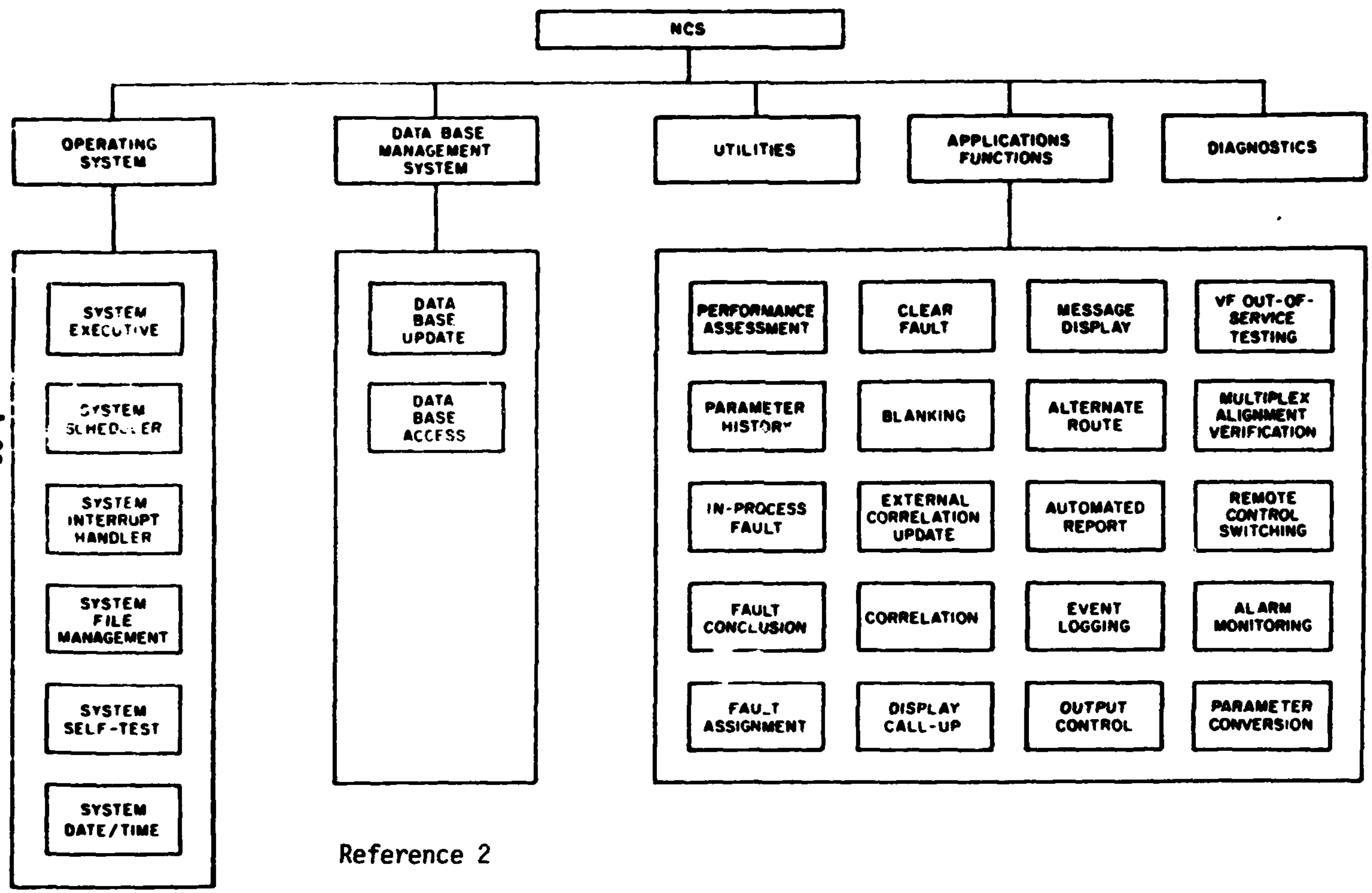
4) Terminal Equipment. The NCS contains up to five controller terminals, interfaced with the computer, one of which shall be designated

the master nodal controller terminal. The controller terminals will contain a visual display, keyboard, and terminal printer.

5) <u>Line Printer Equipment</u>. The NCS contains at least one impact line printer, interfaced with the computer, capable of printing a minimum of 300 lines per minute for the prime purpose of providing hard copies of data base information.

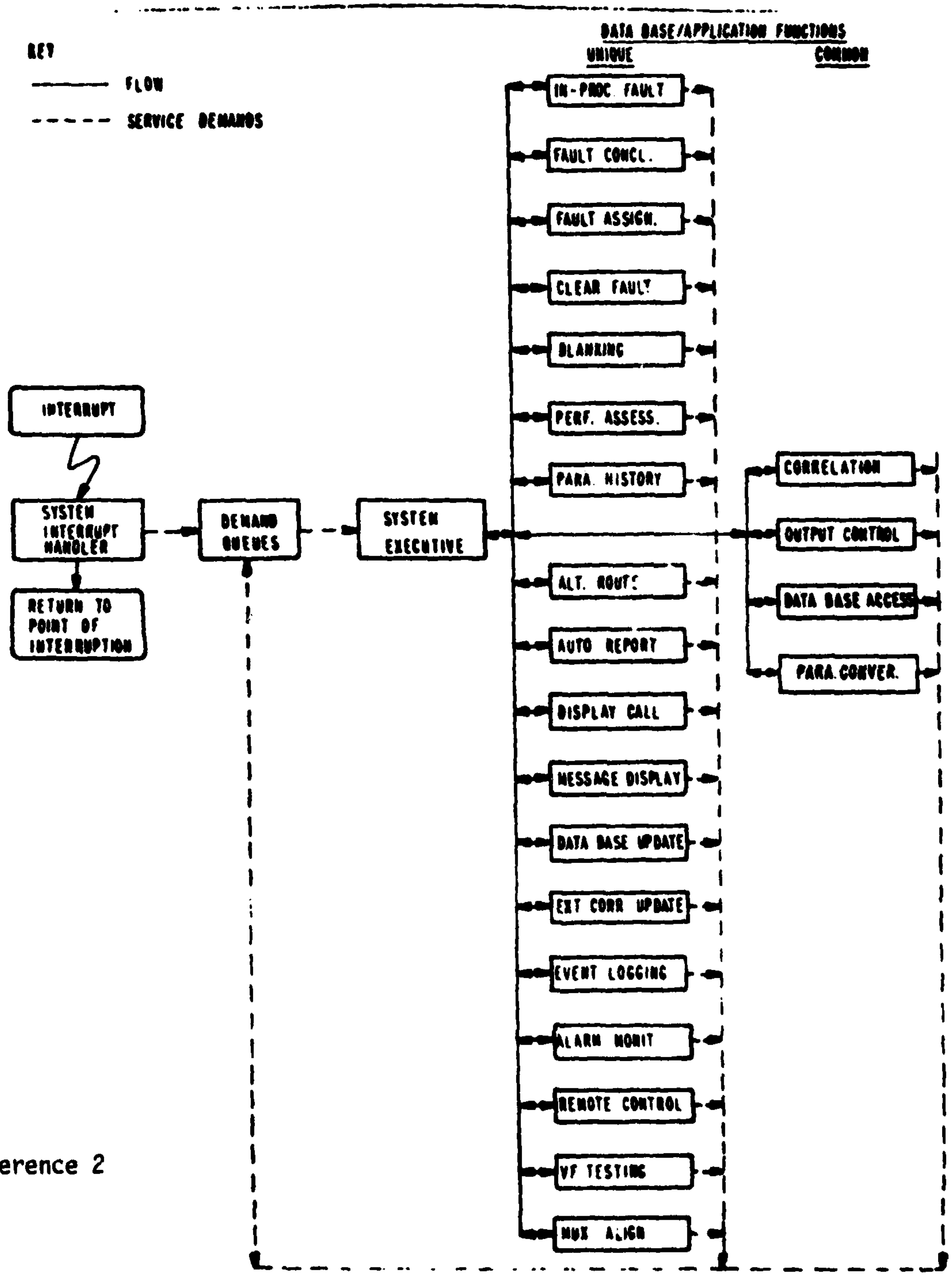
6) <u>Data Interface Equipment (DIE)</u>. The NCS contains a DIE, interfaced with the computer, capable of transmitting and receiving messages via 2400 baud communications ports. Ports will permit interfacing via appropriate external devices (such as data modems) and dedicated lines, with one SCS and up to eight station control level interfaces to MASs. Seven spare ports, of which 3 will accommodate SYSCON requirements, shall be included in this equipment.

<u>NCS Software Functional Characteristics</u> -- Figure A-19 depicts the NCS software requirements. The operating system performance characteristics is as described in 5.d.(1). The utilities and diagnostics as indicated in Figure A-19 shall be provided in accordance with 3.3.8 (Appendix B). Figure A-20 describes the logical control of the NCS functions. The flow lines of Figure A-20 indicate program actions controlled by interrupts and program actions controlled by the executive. The service demand lines indicate the sources of service demands and indicate executive access to the demand queues to determine the next function to be executed. The design of the hardware and software of the NCS processor equipment, while it shall incorporate all of the functions and capabilities indicated in Figures 8 and 9, shall not preclude the addition of other functions.



Reference 2

Figure A-19. Nodal Control Subsystem Software



Reference 2

Figure A-20. Control of the NCS Processor Functions

1) Operating System Performance Characteristics. An operating system tailored to NCS hardware and application requirements may be generated from an existing operating system capability. Only those modules required by the application requirements will be incorporated into the operating system. The operating system shall contain real-time and disk support features. The major functions to be included in the operating system are described in the following subsections:

a) System Executive. The system executive controls the allocation of resources such as main memory, processor timing, input/output, and mass storage. It also handles communications between application program modules and the operating system. In support of this function, main memory will be mapped into areas, to support, resident portions of the operating system, resident application program modules (as applicable), and a multiple-use area for non-resident operating system or application program modules. The multiple-use area shall support memory partitions allowing more than one non-resident program module to be present in main memory at a time, so that the switching of execution from one program module to another can be accomplished in main memory when practical. The system executive shall be supported by an appropriate routine to select messages or requests to be processed, and assign control to the proper data base or application function. When this routine is entered, the highest priority demand queue will be examined for the presence of an entry. If none exists, the next highest priority demand queue will be examined for an entry. When an entry is found, the message or request will be extracted from the queue, its message type will be determined, and the appropriate function will be called and presented with the message extracted from the queue. When the called function has completed or suspended its tasks, it will return control to the executive routine. Called functions may add messages or requests to the demand queues. In general, an application program module shall call system executive of the operating system to:

- Perform I/O operations.
- Allocate and release disk space.
- Suspend or terminate itself.
- Schedule other program modules for execution.
- Set time of execution cycles.
- Obtain partition status information.
- Obtain the current time from the real-time clock.
- Load a background disk resident program segment.

(b) System Scheduler. The system scheduler shall organize and schedule application program modules for execution. It shall include the activation, termination, suspension and preparation of application program modules for execution. Scheduling of application program modules shall be based on demands for particular modules and the assigned priorities of the modules.

(c) System Interrupt Handler. The system interrupt handler shall allow the computer to recognize the occurrence of an asynchronous external event. The processor shall service that event utilizing transfer vectors and interrupt priorities and levels. When an interrupt is recognized, processor control shall be transferred to an interrupt processing routine. The operating system shall maintain queues for the use of I/O devices and shall overlap I/O operations with processing. The I/O control function shall set up and schedule the operations necessary to perform requested I/O actions, shall transfer data from main memory to I/O devices or mass storage, from I/O devices or mass storage to main memory. The system interrupt handler shall be supported by appropriate routines such that when a complete message or request has been received, it shall be placed in the appropriate priority demand queue for scheduling actions.

d) System File Management. System file management shall include file management and I/O support. File management shall provide for the creation of new data files and the modification or elimination of existing files. This function shall permit file organization on disk to be specified to be either contiguous (fixed length) or non-contiguous (dynamically allocated). It shall also permit multiple logical records for sequential and relative record file I/O to be blocked into physical records to minimize access time. I/O support shall provide for uniform and consistent access to the I/O devices by the application program modules.

e) System Start-Up and Recovery. The operating system shall support system start-up and recovery routines which shall provide the features specified in 3.2.1.13.

f) System Self-Test. The system self-test shall provide processor and memory error-checking, and I/O device integrity-checking on a non-interferring, background basis. It shall also identify appropriate error and abnormal state conditions or indications reflecting conditions requiring controller attention. A condition such as illegal or incomplete commands and device time-outs, shall result in an appropriate error condition message.

Growth and Spare Requirements. The implementation of the NCS is specified (by ATEC 10000) to include the capability to satisfy certain growth and spare requirements, the spare capacities must be provided in the basic NCS configuration. Growth may be attainable through application of the same standard procedures utilized to attain the basic NCS configuration which, for example, may involve the interconnection of additional hardware. Growth shall be attainable in blocks or units which are readily separable from the basic NCS assets. Growth and spare requirements are contained in the following subsections.

1) Interface Spare Requirements. The NCS is provided with seven spare 2400 baud ports which are physically identical to the NCS/MAS and NCS/SCS ports. The standard protocol will be applied to these ports.

2) Processing Growth and Spare Requirements. The implementation of the NCS shall make provision for attaining the growth and spare capacities of primary memory, secondary memory, and processing power as specified in the following subsections.

a. Spare Processing Requirements. The processor (s) used at the sector, node and in the station level controller terminal set shall include a spare memory capacity of both primary and secondary storage, and a spare processing capacity. The spare memory capacity measured in terms of unused character storage, and spare processing capacity, measured in terms of available processing time, shall be at least 25% of the storage and processing required for sustained operation of the system at the rates specified in 3.2.6.

b. Growth Processing Requirements. The processor (s) used at the sector and node shall allow a future growth of memory and processing capacity beyond that specified above as spare. The growth shall permit the later addition of the evolving SYSCON capabilities. The memory and/or processing growth requirements may be accommodated by including the growth capacities as additional spare capacity beyond that specified in 3.2.2.8.1.

First, in addition to the capability to accommodate the specified ATEC functions, there shall be provided the capability to execute an additional ten tasks per five seconds. A task is defined to require 12,000 machine cycles and three accesses to secondary memory for the transfer of data blocks comprised of 2,000 equivalent 16-bit words to or from primary memory plus two additional, identical, accesses for application programs, if they are not all resident in primary memory. The 2000 word data blocks are assumed to be contiguous and obtainable without interruption from other tasks. The mean time allowed from the arrival at a port of the NCS, of the stimulus for each of these tasks, to execution completion is to seconds, and the three sigma point is not to exceed five seconds. For the purpose of this specification, the task arrival distribution is defined as Poisson.

c. Message Processing. The second growth requirement for processing power shall allow for the capacity to transfer additional messages through the NCS, utilizing it as a message switch. This included distinct message types arriving via implemented spare ports where those messages are destined for the communication link to the SCS. Also included are the messages arriving from the SCS port and destined for one of the spare ports. For the defined growth load of messages traversing the NCS, the processing impact on the NCS of the message switching function is to be such as not to degrade the capability of the NCS to satisfy the other requirements specified in this Appendix. The growth message switching capacity has a defined maximum of 20% mean utilization on each of three 2400 baud spare ports and 60% mean utilization on the SCS port with evenly distributed destinations among the three spare ports. The subject messages are 80 character messages with a Poisson arrival distribution. The capability to effect the transfer of messages is defined as an extension of the basic NCS message transfer capability and therefore, imposes no additional, distinguishable, functional requirements on the NCS in support of the growth message processing requirement.

APPENDIX B

SOFTWARE SIZING DATA

Appendix B presents the tables containing software sizing data corresponding to the recommended software modifications and additions to the various system and subsystems addressed by this study. Included are:

TABLE B-1. SNCC

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES)	
		PROG	DATA
NCC MESSAGE HANDLER			
READDRESS SEGMENT	25F	375	
TOTAL	25	375	

TABLE B-2. SB-3865

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES) PROG	DATA
TRAFFIC PARAMETER COLLECTION			
OBTAIN PARAMETERS FOR (R44, 3, 4, 6)	25F	375	
BUILD MESSAGES (R44, R3, R4, R6)& QUEUE	75F	1125	108
SET MESSAGE PENDING FLAGS	15F	225	
STATUS PARAMETER COLLECTION			
OBTAIN STATUS CHANGES PENDING	25F	375	
BUILD R MESSAGES (R21, R22, R23) & QUEUE	75F	1125	81
MESSAGE I/O DRIVER/PROCESSOR			
CHECK AND CLEAR MESSAGE PENDING FLAGS	25F	375	
FLUSH MESSAGE Q	25F	375	
HARDWARE DIAGNOSTIC (EQUIPMENT STATUS)			
DIAGNOSE HARDWARE, OBTAIN/EVALUATE RESULTS, BUILD RXX MSG	100F	1500	27
ATEC OUTPUT			
PROTOCOL HANDLER, PARITY, REC ACK	100A	300	
MESSAGE OUTPUT	50A	150	27
INPUT PROCESSING			
MESSAGE INPUT, DECODE (ACK, NAK)	80A	240	
TOTAL	365F 230A	6125	243

TABLE B-3. TTC-39

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES)	
		PROG	DATA
TRUNK ROUTING FAILURE			
BUILD MSG IN BUFFER	60F	900	24
SET MSG WAITING FLAG FOR OUTPUT PROCESSOR	15F	225	
RING AROUND ROSEY			
BUILD R60 MSG (USE EXISTING)	15F	225	
SET RAR INDICATOR, SET MSG WAITING FLAG	15F	225	
TOTAL	105	1575	24

TABLE B-4. TTC-39 REPORT CONSOLIDATION PROCESSOR Page 1 of 1

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES) PROG	DATA
ICD 004 INPUT			
CHARACTER INPUT	50A	150	243
PROTOCOL HANDLER, REC ACK	120A	360	
ERROR CHECKS, VERTICAL, HORIZONTAL, SKEW PARITY	150A	450	
DROP IDLES	25A	75	
MESSAGE PROCESSING			
CHARACTER CONVERSION - TO OUTPUT FORMAT	50A	150	243
QUEUE MESSAGE	25A	75	
RAISE MESSAGE FLAG	15A	45	
DEDICATED CIRCUIT OUTPUT			
MESSAGE FORMAT AND PROTOCOL HANDLER	100A	300	
GENERATE ERROR CHECKING - CRC	50A	150	
MESSAGE OUTPUT CONTROL	60A	180	54
DEDICATED CIRCUIT INPUT			
MESSAGE INPUT CONTROL	50A	150	54
PROTOCOL HANDLER	100A	300	
ERROR CHECKS	30A	90	
MESSAGE PROCESSING			
STRIP OVERHEAD	25A	75	
DECODE AND CONVERT MSG FOR APPROPRIATE TTC-39	75A	225	
QUEUE & RAISE MESSAGE FLAG	15A	45	54
ICD 004 OUTPUT			
PROVIDE IDLES	50A	150	
PROTOCOL HANDLER AND PARITY	150A	450	
CHARACTER OUTPUT	50A	150	243
TOTAL		3570	891

TABLE B-5. DSCS-TCE

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES) PROG	DATA
EIRP			
OBTAIN EIRP MEASUREMENT AND COMPUTE HISTORICAL PROFILE	40F	600	
FILE IN LOCAL DISPLAY DB	10F	150	
BUILD MSG IN NCE MSG Q	25F	375	
RAISE FLAG AND TRANSMIT PERIODICALLY	15F	225	
RSS			
OBTAIN RSS MEAS. AND COMPUTE HIST. PROFILE	25F	375	
FILE IN LOCAL DISPLAY DB	10F	150	
FORMAT MSG IN NCE MESSAGE Q	25F	375	
EARTH TERMINAL STATUS ALARMS			
FORMAT ATEC COMPATIBLE MSG	25F	375	
Q FOR CIS TRANSMISSION, RAISE FLAG	10F	150	
TRANSMIT MSG WITH ATEC 10000 PROTOCOL	25F	375	100
FORMAT CS MSG FOR EXCEPTION REPORT & QUEUE FOR TX	25F	375	
TOTAL	235	3525	100

TABLE B-6. DSCS-NCE

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES) PROG	DATA	
HISTORICAL PROFILE MSG				
FILE IN LOCAL DB (EIRP,RSS), MODIFY DISPLAY DB	75F	1125		
REFORMAT FOR TX TO ACOC	25F	375		
RAISE FLAG IN Q FOR TRANSMISSION	10F	150		
EXCEPTION REPORT				
RECORD IN DATA BASE AND UPDATE DISPLAY	75F	1125		
REFORMAT FOR TX TO ACOC	25F	375		
TOTAL	210	3150		

TABLE B-7. ATEC-CIS

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES) PROG	DATA
ULS INPUT PROCESSING			
ACOC ADDRESS ACCEPTED	15F	225	
ERROR CHECK	---		
NODE INPUT PROCESSING			
RECOGNIZE MESSAGE FOR ULS	15F	225	
ERROR CHECK	---		
TOTAL	30F	450	

TABLE B-8. ATEC-NODE

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES) PROG	DATA
ULS INPUT FROM CIS			
ACOC ADDRESS ACCEPTED	15F	225	
TCE INPUT FROM CIS			
DECODE TCE MESSAGE	25F	375	
DIRECT TO TCE/TTS CORRELATION	10F	150	
TCE/TTS CORRELATION			
CORRELATE TCE ALARMS WITH TTS STATUS	150F	2250	
STORE FAULTS	25F	375	
PASS ON UNCORRELATED REPORTS TO SECTOR	25F	375	
TCE/SECTOR OUTPUT			
READDRESS REPORT TO SECTOR	25F	375	
QUEUE MESSAGE	---		
RAISE MESSAGE FLAG	---		
TOTAL	275	4125	

TABLE B-9. ATEC-SECTOR

PROGRAM MODULE	# INSTR LANGUAGE	STORAGE (BYTES) PROG	DATA
ULS INPUT FROM NODE			
ACOC ADDRESS ACCEPTED	15F	225	
ACOC OUTPUT			
QUEUE MESSAGE FOR AUTODIN	10F	150	
TCE INPUT FROM NODE (AT SECTOR)			
DECODE TCE MESSAGE	25F	375	
DIRECT TO TCE/TTS CORRELATION	10F	150	
TCE/TTS CORRELATION			
CORRELATION ALGORITHM	150F	2250	
STORE FAULTS	25F	375	
TOTAL	235	3525	

TABLE B-10. ACOC-WWOLS SIZING SUMMARY (1 of 7)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Common	Theatre	Connectivity	Autovon Control
CRT Interface	Performs CRT I/O line handling	200	3000	2000	X			
ACOC - WWOLS - Autodin Input Interface Manager	Performs ACOC - Autodin input line handling	100	1500	1000	X			
ACOC - WWOLS - TTC-39 Input Interface Manager	Performs ACOC - TTC-39 input line handling	100	1500	1000	X			
ACOC - WWOLS - Autodin Output Interface Manager	Performs ACOC - Autodin output line handling	100	1500	1000	X			
ACOC - WWOLS - TTC-39 Output Interface Manager	Performs ACOC - TTC-39 output line handling	100	1500	1000	X			
Autodin Segment Decode	Decodes Autodin input messages	50	750		X			
TTC-39 Segment Decode	Decodes TTC-39 input messages	50	750		X			
Autodin Segment Encode	Encodes messages for Autodin output	50	750		X			
TTC-39 Segment Encode	Encodes messages for TTC-39 output	50	750		X			
OS Peripheral Interface	Performs peripheral I/O line handling	150	2250	300	X			
Output Message Formatter	Formats messages to be output	150	2250	300	X			
Autodin Display File Mgr	Performs retrieval of Autodin displays	200	3000	300		X		
Theatre Display File Mgr	Performs retrieval of theatre displays	100	1500	300		X		
Theatre Report File Mgr	Performs retrieval of theatre reports	100	1500			X		
TTC-39 Interface Protocol Mgr	Interprets TTC-39 interface protocol	150	2250			X		
TTC-39 Interface Buffer Mgr	Maintains the TTC-39 buffers	100	1500			X		
TTC-39 Journal Manager	Maintains the TTC-39 Journal	175	2625			X		

TABLE B-10. ACOC-WWOLS SIZING SUMMARY (2 of 7)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Common	Theatre	Connectivity	Autovon Control
TTC-39 I/O Queue Manager	Maintains the TTC-39 I/O Queue	50	750			X		
Message Sort	Sorts all messages	175	2625			X		
Node Historical File Control	Records all node data base changes	200	3000				X	
Display Data Sets Maint.	Performs retrieval of display data sets	100	1500				X	
Link Accessed File Control	Retrieves link files	175	2625				X	
Route Accessed File Control	Retrieves route files	150	2250				X	
CCSD Accessed File Control	Retrieves CCSD files	200	3000				X	
TTS Alarm Level Analysis	Analyzes TTS Alarm levels	100	1500				X	
Report Data Sets Maint.	Maintains all report data sets	200	3000				X	
CCSD Preplanned Altroute File Mgr	Maintains CCSD preplanned altroute files	150	2250				X	
DI Group Preplanned Altroute File Manager	Maintains DI Group preplanned alroute files	150	2250				X	
DSCS Alarm Level Analysis	Analyzes DSCS Alarm levels	100	1500				X	
Operator Console Controller	Performs console handling	250	3750	300	X			
I/O Queue Manager	Maintains I/O Queues	100	1500					X
Timer Manager	Maintains time function	50	750					X
Switch Traffic History File Mgr	Records all switch traffic data base changes	150	2250					X
Display Files Manager	Performs retrieval of display files	150	2250					X
Report Files Manager	Performs retrieval of report files	150	2250					X

TABLE B-10. ACOC-WWOLS SIZING SUMMARY (3 of 7)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Common	Theatre	Connectivity	Autovon Control
Alarm Level Control	Determines proper alarms	150	2250					X
Switch Equip. Status & History File Manager	Maintains equip. status and data base changes for switch	200	3000					X
Switch Config. File Mgr	Maintains Switch Configuration	100	1500					X
DB Consistency Algorithm	Maintains data base consistency	250	3750					X
ACOC Message Processor	Handles ACOC messages	50	750			X		
Autodin Message Processor	Handles Autodin messages	50	750			X		
Autodin Query Handler	Determines Autodin information required	150	2250			X		
Connectivity File Mgr	Maintains connectivity information	150	2250			X		
Autodin Failure Analysis	Analyzes Autodin failures	225	3375			X		
Autodin Failure/Alarm Control	Generates Autodin alarms	175	2625			X		
Autodin File Managers	Maintains Autodin files	100	1500			X		
On-Line Change	Performs on-line data base updates	150	2250			X		
Data Base Consistency Algo	Maintains data base consistency	250	3750			X		
Text Only Processor	Converts text to CRT format	50	750			X		
Control Action Journal	Retrieves and updates control action journal	150	2250			X		
Operator Activity Analysis	Decodes operator input information	100	1500			X		
Connectivity Display File Mgr	Performs retrieval of Connectivity files	200	3000			X		

TABLE B-10. ACOC-WWOLS SIZING SUMMARY (4 of 7)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Common	Theatre	Connectivity	Autovon Control
Autovon Display File Mgr	Maintains Autovon display files	200	3000			X		
Theatre Alarm Monitor	Checks for new incoming alarms	250	3750			X	X	X
Alarm Panel Control	Handles alarm panel interface	100	1500			X		
ATEC Queue Management	Maintains ATEC Queues	100	1500				X	
ATEC Report Processing	Decodes ATEC Reports	100	1500				X	
ATEC Report Analysis	Analyzes ATEC Reports	125	1875				X	
DSCS Queue Processing	Maintains DSCS Queues	100	1500				X	
DSCS Message Processing	Decodes DSCS messages	150	2250				X	
DSCS Message Analysis	Analyzes DSCS messages	125	1875				X	
Preplanned Altroute Maint.	Maintains preplanned altroutes	350	5250				X	
On-Line Change	Performs on-line data base updates	150	2250				X	
DB Consistency Algorithm	Maintains Data Base Consistency	250	3750				X	
Timeout Control	Allows delay for update responses	50	750				X	
Trans. System Control Alarm Generation	Generates Transmission System alarms	250	3750				X	
NCE Historical File Control	Records all NCE data base changes	100	1500				X	
TTS Status Control	Extracts status from TTS reports	200	3000				X	
TTS Configuration Control	Extracts Configuration from reports	200	3000				X	
DSCS Status Control	Extracts Status from DSCS reports	200	3000				X	
Query Processor	Determines information required	150	2250				X	

TABLE B-10. ACOC-WWOLS SIZING SUMMARY (5 of 7)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Common	Theatre	Connectivity	Autovon Control
Message Text Processor	Converts messages to CRT format	50	750				X	
Controller Activity Journal	Records Controller activity records	150	2250				X	
Operator Activity Analysis	Analyzes operator activity	75	1125				X	
Control Action Response Gen.	Generates response to control action	100	1500				X	
DSCS Exception Correlation	Correlates DSCS exceptions	250	3750				X	
CCSD Altroute Calculation	Calculates CCSD altroutes	850	12750				X	
CCSD Altroute Implementation	Implements CCSD altroutes	600	9000				X	
DI Group Altroute Calculation	Calculates DI Group altroutes	650	9750				X	
DI Group Altroute Implementation	Implements DI Group altroutes	600	9000				X	
Alarm Level Control	Determines proper alarm	200	3000				X	
PMP Processor	Handles PMP data input	50	750				X	
Input Journal Manager	Records data inputs	150	2250					X
TTC-39 Report Analysis	Analyzes TTC-39 reports	300	4500					X
SB-3865 Report Analysis	Analyzes SB-3865 reports	100	1500					X
Periodic Report Monitor	Schedules periodic reports	100	1500					X
Timeout Evaluation	Analyzes timeouts	50	750					X
Failure Correlation Algo	Correlates reported failures	450	6750					X
Information Only Processing	Records information only reports	100	1500					X

TABLE B-10. ACOC-WWOLS SIZING SUMMARY (6 of 7)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Common	Theatre	Connectivity	Autovon Control
Calls Offered	Monitor Service to high priority subscribers	400	6000					X
Transmission Plant Status Assessment	Extract status from transmission information reports	300	4500					X
Trunk Group Status File Mgr	Extract trunk group status from reports	150	2250					X
Trans. Information Processor	Assess transmission statistics for failures	100	1500					X
Connectivity Correlation Info Identification	Obtains corresponding information from ATEC	100	1500					X
Trans. Failure Correlation Algo	Correlate information and generate alarms	250	3750					X
Performance Prediction	Predicts performance	150	2250					X
Threshold Modification	Revises thresholds	50	750					X
Threshold Assessment	Evaluate thresholds	100	1500					X
Traffic Summary Processor	Handles Traffic Summary reports	150	2250					X
Traffic Thresholding	Examine traffic data for stress	250	3750					X
ULS Status File Manager	Extract ULS status from failure report	100	1500					X
ULS Configuration File Mgr	Extract ULS config. from failure report	100	1500					X
Error/Failure Processor	Handles error/failure reports	75	1125					X
Switch Status Assessment	Determine Switch Status	75	1125					X
Failure Condition Analysis	Analyze failure conditions	100	1500					X
Alarm Cascade Suppression	Suppress alarm cascading	100	1500					X

TABLE B-10. ACOC-WWOLS SIZING SUMMARY (7 of 7)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Progra. Occupancy (Bytes)	Data Occupancy (Bytes)	Common	Theatre	Connectivity	Autovon Control
Text Only Processor	Convert text to CRT format	50	750					X
User Status and Directory File Manager	Extract user status and directory information when data base updated	75	1125					X
User Detail File Manager	Maintain user detail files	100	1500					X
On-Line Change	Performs on-line data base changes	150	2250					X
Suscriber Addition	Records subscriber additions	100	1500					X
Suscriber Deletion	Records subscriber deletions	100	1500					X
Control Activity Journal	Records control activity	150	2250					X
Operation Activity Analysis	Analyzes operation activity	100	1500					X
Alarm Control	Determines proper alarm	75	1125					X
	TOTAL LINES OF CODE = 18,575							
	TOTAL PROGRAM OCCUPANCY = 276,750							
	TOTAL DATA OCCUPANCY = 7,500							

TABLE B-11. ACOC-WWOLS RESIDENT AND SUPPORT OVERLAY SIZING SUMMARY (1 of 3)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Resident	Theatre	Connectivity	Autovon Control
CRT Interface	Performs CRT I/O line handling	200	3000	2000	X			
ACOC - WWOLS - Autodin Input Interface Mgr	Performs ACOC - Autodin input line handling	100	1500	1000	X			
ACOC - WWOLS - TTC-39 Input Interface Mgr	Performs ACOC - TTC-39 input line handling	100	1500	1000	X			
ACOC - WWOLS - Autodin Output Interface Mgr	Performs ACOC - Autodin output line handling	100	1500	1000	X			
ACOC - WWOLS - TTC-39 Output Interface Mgr	Performs ACOC - TTC-39 output line handling	100	1500	1000	X			
Autodin Segment Decode	Decodes Autodin input messages	50	750		X			
TTC-39 Segment Decode	Decodes TTC-39 input messages	50	750		X			
Autodin Segment Encode	Encodes messages for Autodin output	50	750		X			
TTC-39 Segment Encode	Encodes messages for TTC-39 output	50	750		X			
OS Peripheral Interface	Performs peripheral I/O line handling	150	2250	300	X			
Output Message Formatter	Formats messages to be output	150	2250			X	X	X
Autodin Display File Mgr	Performs retrieval of Autodin displays	200	3000	300		X		
Theatre Display File Mgr	Performs retrieval of theatre displays	100	1500	300		X		
Theatre Report File Mgr	Performs retrieval of theatre reports	100	1500			X		
TTC-39 Interface Protocol Mgr	Interprets TTC-39 interface protocol	150	2250			X		
TTC-39 Interface Buffer Mgr	Maintains the TTC-39 buffers	100	1500			X		
TTC-39 Journal Manager	Maintains the TTC-39 Journal	175	2625			X		

TABLE B-11. ACOC-WWOLS RESIDENT AND SUPPORT OVERLAY SIZING SUMMARY (2 of 3)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Resident	Theatre	Connectivity	Autovon Control
TTC-39 I/O Queue Mgr	Maintains the TTC-39 I/O Queue	50	750			X		
Message Sort	Sorts all messages	175	2625			X		
Node Historical File Control	Records all node data base changes	200	3000			X		
Display Data Sets Maint.	Maintains all display data sets	100	1500				X	
Link Accessed File Control	Retrieves link files	175	2625				X	
Route Accessed File Control	Retrieves route files	150	2250				X	
CCSD Accessed File Control	Retrieves CCSD files	200	3000				X	
TTS Alarm Level Analysis	Analyzes TTS Alarm levels	100	1500				X	
Report Data Sets Maint.	Maintains all report data sets	200	3000				X	
CCSD Preplanned Altroute File Manager	Maintains CCSD preplanned altroute files	150	2250				X	
DI Group Preplanned Altroute Mgr	Maintains DI Group preplanned alroute files	150	2250				X	
DSCS Alarm Level Analysis	Analyzes DSCS Alarm levels	100	1500				X	
Operator Console Controller	Performs console handling	250	3750			X	X	X
I/O Queue Manager	Maintains I/O Queues	100	1500					X
Timer Manager	Maintains time function	50	750					X
Switch Traffic History File Mgr	Records all switch traffic data base changes	150	2250					X
Display Files Manager	Performs retrieval of display files	150	2250					X
Report Files Manager	Performs retrieval of report files	150	2250					X
Alarm Level Control	Determines proper alarms	150	2250					X

TABLE B-11. ACOC-WWOLS RESIDENT AND SUPPORT OVERLAY SIZING SUMMARY (3 of 3)

PROGRAM NAME	FUNCTION	NO. INST. HOL	Program Occupancy (Bytes)	Data Occupancy (Bytes)	Resident	Theatre	Connectivity	Autovon Control
Theatre Alarm Monitor	Informs theatre control of alarms	250	3750			X	X	X
Switch Equip. Status & History File Manager	Maintains equip. status and data base changes for switch	200	3000					X
Switch Config. File Mgr	Maintains switch configuration	100	1500					X
DB Consistency Algorithm	Maintains data base consistency	250	3750					X
					18750	27225	27750	27375

TABLE B-12. ACOC-WWOLS THEATRE FUNCTIONAL OVERLAY SIZING SUMMARY

PROGRAM NAME	NO. INST. HOL	Program Occupancy (Bytes)	Input Message Processing	Autodin Msg. Proc.	Autodin Failure Proc.	Autodin Data Base Change	Connectivity & Autovon DB Change	Text Only Processing	Operator Action I/O Proc.	Alarm Processing	
ACOC Message Processor	50	750	X								
Autodin Message Processor	50	750	X								
Autodin Query Handler	150	2250		X							
Connectivity File Mgr	150	2250		X							
Autodin Failure Analysis	225	3375			X						
Autodin Failure/Alarm Control	175	2625			X						
Autodin File Managers	100	1500				X					
On-Line Change	150	2250				X					
Data Base Consistency	250	3750				X					
Text Only Processor	50	750						X			
Control Action Journal	150	2250							X		
Operator Activity Analysis	100	1500							X		
Connectivity Display File Mgr	200	3000							X		
Autovon Display File Mgr	200	3000							X		
Alarm Panel Control	100	1500								X	
			1500	4500	6000	7500		750	9750	1500	

TABLE B-13. ACOC-WWOLS CONNECTIVITY FUNCTIONAL OVERLAY SIZING SUMMARY (1 of 2)

PROGRAM NAME	NO. INST. HOL	Program Occupancy (Bytes)	ATEC I/O Message Queue Management	DSCS I/O Message Q Management	Data Base Update Proc.	TTS Status Update Proc.	TTS Config. Update Proc.	DSCS Status Update Proc.	DSCS Config. Update Proc.	Data Base Query	Text Only Msg. Proc.	Controller I/O Proc.	Alarm Processing	PMP Processing	
ATEC Queue Management	100	1500	X												
ATEC Report Processing	100	1500	X												
ATEC Report Analysis	125	1875	X												
DSCS Queue Processing	100	1500		X											
DSCS Message Processing	150	2250		X											
DSCS Message Analysis	125	1875		X											
Preplanned Altroute Maint.	350	5250			X										
On-Line Change	150	2250			X										
DB Consistency Algorithm	250	3750			X										
Timeout Control	50	750			X										
Transmission System Control Alarm Generation	250	3750			X										
NCE Historical File Control	100	1500			X										
TTS Status Control	200	3000				X									
TTS Configuration Control	200	3000					X								
DSCS Status Control	200	3000						X							
DSCS Configuration Control	300	4500							X						
Query Processor	150	2250								X					
Message Text Processor	50	750									X				

TABLE B-13. ACOC-MWOLS CONNECTIVITY FUNCTIONAL OVERLAY SIZING SUMMARY (2 of 2)

PROGRAM NAME	NO. INST. HOL	Program Occupancy (Bytes)	ATEC I/O Message Queue Management	DSCS I/O Message Q Management	Data Base Update Proc.	TTS Status Update Proc.	TTS Config. Update Proc.	DSCS Status Update Proc.	DSCS Config. Update Proc.	Data Base Query	Text Only Msg. Proc.	Controller I/O Proc.	Alarm Processing	PMP Processing	
Controller Activity Journal	150	2250										X			
Operator Activity Analysis	75	1125										X			
Control Action Response Gen.	100	1500										X			
DSCS Exception Correlation	250	3750										X			
CCSD Altroute Calculation	850	12750										X			
CCSD Altroute Implementation	600	9000										X			
DI Group Altroute Calculation	650	9750										X			
DI Group Altroute Implementation	600	9000										X			
Alarm Level Control	200	3000											X		
PMP Processor	50	750												X	
			4875	5625	17,250	3000	3000	3000	4500	2250	750	49,125	3000	750	

TABLE B-14. ACOC-WWOLS AUTOVON CONTROL FUNCTIONAL OVERLAY SIZING SUMMARY (1 of 2)

PROGRAM	NO. INST. HOL	Program Occupancy (Bytes)	Info Only Processing	Calls Offered	Traffic Summary	Transmission Information	Error/Failure Reporting	Text Only Processing	Controller Input Proc.	Alarm Processing	Data Base Modification	Data Acquisition	Periodic Processing		
Input Journal Manager	150	2250										X			
TTC-39 Report Analysis	300	4500										X			
SB-3865 Report Analysis	100	1500										X			
Periodic Report Monitor	100	1500											X		
Timeout Evaluation	50	750											X		
Failure Correlation Algo	450	6750											X		
Information Only Processing	100	1500	X												
Calls Offered	400	6000		X											
Transmission Plant Status Accessment	300	4500				X									
Trunk Group Status File Manager	150	2250				X									
Transmission Information Processor	100	1500				X									
Connectivity Correlation Info Identification	100	1500				X									
Transmission Failure Correlation Algorithm	250	3750				X									
Performance Prediction	150	2250				X									
Threshold Modification	50	750				X									
Threshold Assessment	100	1500				X									

TABLE B-14. ACOC-WWOLS AUTOVON CONTROL FUNCTIONAL OVERLAY SIZING SUMMARY (2 of 2)

PROGRAM	NO. INST. HOL	Program Occupancy (Bytes)	Info Only Processing	Calls Offered	Traffic Summary	Transmission Information	Error/Failure Reporting	Text Only Processing	Controller Input Proc.	Alarm Processing	Data Base Modification	Data Acquisition	Periodic Processing		
Traffic Summary Proc.	150	2250			X										
Traffic Thresholding	250	3750			X										
ULS Status File Manager	100	1500					X								
ULS Configuration File Manager	100	1500					X								
Error/Failure Processor	75	1125					X								
Switch Status Assessment	75	1125					X								
Failure Condition Analysis	100	1500					X								
Alarm Cascade Suppresion	100	1500					X								
Text Only Processor	50	750						X							
User Status and Directory File Manager	75	1125									X				
User Detail File Manager	100	1500									X				
On-Line Change	150	2250									X				
Suscriber Addition	100	1500									X				
Suscriber Deletion	100	1500									X				
Control Activity Journal	150	2250							X						
Operation Activity Analysis	100	1500							X						
Alarm Control	75	1125								X					
			1500	6000	6000	18,000	8250	750	3750	1125	7875	8250	10,500		

APPENDIX C

SCENARIOS

Four scenarios from the first technical report representing major system level stresses are described in the following subsections. Each description includes:

- o A synopsis of the events causing the stress
- o A listing of the primary system stresses (i.e., the stresses on the system of primary interest)
- o A listing of colateral stresses (i.e., the stresses on systems not of primary interest)
- o The estimated time duration of the causal event
- o The stress indicating parameters
- o The stress detection and isolation method
- o The anticipated control techniques
- o A narrative description of events relating to the stress

The scenarios described are:

- o Node Outage (Scenario Two)
- o AUTOVON Trunk Group Failure (Scenario Nine)
- o Partial AUTOVON Trunk Group Failure (Scenario Ten)
- o General AUTOVON Traffic Overload (Scenario Sixteen)

Scenario Two - Node Outage

I. Synopsis: The DCS station at Feldberg is totally destroyed during normal peak busy hour. The equipment destroyed includes the TTC-39 switch, all RF and multiplex equipment, emergency power equipment, distribution frames, antenna and tower equipment. This type of scenario is interesting because it represents the failure of a complete system node where repair will take considerable time and where no local actions can aid in restoring service. The Feldberg station was picked for this scenario because it is the major Europeon gateway AUTOVON switch and also carries a significant amount of intra-European tandem traffic. Thus, the most severe effect on transatlantic traffic will be demonstrated by this scenario.

II. System Stress

A. Link Connectivity: The backbone links disrupted in this scenario are the following:

Link Number	From	To
M0293	Feldberg	Breitsol
M0298	Feldberg	Rhein Main
M0063	Feldberg	Langerkopf
M0891	Feldberg	Adenau
M0291	Feldberg	Stein

B. AUTOVON Subsystem Stress

1. Trunk Connectivity: All trunk groups terminating on the Feldberg switch are disrupted. No other trunks traverse the Feldberg station. The trunks terminating on the Feldberg switch include the following:

Destination	Number of Trunks Analog/Digital
Coltano	11/0
Hillingdon	15/6
Donnersburg	30/10
Langerkopf	30/14
Schoenfeld	13/5
Martlesham Heath	13/6
Mt. Vergine	20/0
CONUS	11/39

2. Route Connectivity: The routes which are affected by the loss of Feldberg include those listed in Table C-1.

3. User Access Connectivity: The ULS at Giessen is isolated by the loss of Feldberg.

4. Traffic Performance: The busy hour traffic performance in this scenario is summarized in Table C-2.

TABLE C-1. ROUTES AFFECTED BY LOSS OF FELDBERG NODE

NETWORK IMPACT OF NODE 5 FAILURE

16 PRIMARY,54 SECONDARY AND,26 TERTIARY ROUTES

PRIMARY ROUTES	SECONDARY ROUTES	TERTIARY ROUTES
CON(1)-SCH(4)	CON(1)-HIN(2)	CON(1)-HIN(2)
CON(1)-DON(6)	CON(1)-MAM(3)	CON(1)-MAM(3)
CON(1)-LKF(7)	CON(1)-SCH(4)	CON(1)-SCH(4)
CON(1)-CLO(8)	CON(1)-DON(6)	CON(1)-DON(6)
SCH(4)-CON(1)	CON(1)-LKF(7)	CON(1)-LKF(7)
SCH(4)-MAM(3)	CON(1)-CLO(8)	CON(1)-CLO(8)
SCH(4)-CLO(8)	CON(1)-MRE(9)	CON(1)-MRE(9)
SCH(4)-MRE(9)	CON(1)-PAT(10)	CON(1)-HUM(11)
SCH(4)-HUM(11)	CON(1)-HUM(11)	HIN(2)-DON(6)
DON(6)-CON(1)	HIN(2)-CON(1)	HIN(2)-HUM(11)
LKF(7)-CON(1)	HIN(2)-SCH(4)	MAM(3)-LKF(7)
PAT(10)-CON(1)	HIN(2)-LKF(7)	MAM(3)-MRE(9)
PAT(10)-HIN(2)	HIN(2)-CLO(8)	MAM(3)-PAT(10)
PAT(10)-MAM(3)	HIN(2)-MRE(9)	MAM(3)-HUM(11)
PAT(10)-CLO(8)	MAM(3)-CON(1)	SCH(4)-DON(6)
HUM(11)-CLO(8)	MAM(3)-SCH(4)	SCH(4)-LKF(7)
	MAM(3)-DON(6)	DON(6)-HIN(2)
	MAM(3)-CLO(8)	DON(6)-MAM(3)
	SCH(4)-CON(1)	DON(6)-SCH(4)
	SCH(4)-HIN(2)	DON(6)-MRE(9)
	SCH(4)-MAM(3)	DON(6)-HUM(11)
	SCH(4)-LKF(7)	LKF(7)-MAM(3)
	SCH(4)-CLO(8)	LKF(7)-SCH(4)
	SCH(4)-MRE(9)	LKF(7)-DON(6)
	SCH(4)-PAT(10)	MRE(9)-MAM(3)
	SCH(4)-HUM(11)	MRE(9)-DON(6)
	DON(6)-LKF(7)	
	DON(6)-CLO(8)	
	LKF(7)-HIN(2)	
	LKF(7)-CLO(8)	
	LKF(7)-MRE(9)	
	LKF(7)-PAT(10)	
	LKF(7)-HUM(11)	
	CLO(8)-CON(1)	
	CLO(8)-HIN(2)	
	CLO(8)-MAM(3)	
	CLO(8)-SCH(4)	
	CLO(8)-DON(6)	
	CLO(8)-LKF(7)	
	CLO(8)-MRE(9)	
	MRE(9)-CON(1)	
	MRE(9)-HIN(2)	
	MRE(9)-SCH(4)	
	MRE(9)-LKF(7)	
	MRE(9)-CLO(8)	
	PAT(10)-SCH(4)	
	PAT(10)-DON(6)	
	PAT(10)-LKF(7)	
	HUM(11)-CON(1)	
	HUM(11)-HIN(2)	
	HUM(11)-MAM(3)	
	HUM(11)-SCH(4)	
	HUM(11)-DON(6)	
	HUM(11)-LKF(7)	

TABLE C-2. BUSY HOUR TRAFFIC PERFORMANCE

MEAN GOS=0.3986 VARIANCE OF GOS=0.1799CARRIED TRAFFIC=150.9651

UNWEIGHTED GOS DISTRIBUTION

26	6	7	0	0	0	3	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	2	0	3	0	7	1	0	0
0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
5	4	0	1	0	4	0	0	0	0
0	0	0	2	0	0	0	0	0	18

TRAFFIC WEIGHTED GOS DISTRIBUTION

68.25	19.88	22.13	0.	0.	0.	3.08	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	3.15	0.	0.60	0.	4.80	0.08	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.60	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
65.70	49.05	0.	17.25	0.	50.85	0.	0.	0.	0.
0.	0.	0.	17.10	0.	0.	0.	0.	0.	106.43

	CON	HIL	MAM	SCH	FEL	DON	LKF	CTO	MTV	HUM
CON	0.	0.8217	0.8104	0.8226	1.0000	0.8092	0.8071	0.8115	0.8415	0.8083
HIL	0.8623	0.	0.0000	0.0060	1.0000	0.0195	0.0000	0.0297	0.2709	0.0000
MAM	0.8623	0.0000	0.	0.4217	1.0000	0.2279	0.0000	0.2488	0.0680	0.0000
SCH	0.8647	0.0060	0.2656	0.	1.0000	0.0022	0.0015	0.2713	0.2520	0.2659
FEL	1.0000	1.0000	1.0000	1.0000	0.	1.0000	1.0000	1.0000	1.0000	1.0000
DON	0.8193	0.0195	0.0195	0.0022	1.0000	0.	0.0027	0.0271	0.0013	0.0199
LKF	0.8623	0.0000	0.0000	0.0015	1.0000	0.0007	0.	0.0297	0.0088	0.0000
CTO	0.9365	0.2835	0.2488	0.2713	1.0000	0.0271	0.0297	0.	0.0172	0.0266
MTV	0.9354	0.2709	0.0680	0.2733	1.0000	0.0013	0.0088	0.0172	0.	0.0261
HUM	0.8220	0.0000	0.0000	0.2303	1.0000	0.0016	0.0011	0.0132	0.0748	0.

III. Colateral Stress: Stress to other subsystems which occur because of the implementation of this AUTOVON scenario include the following:

- o 3-1200 baud critical AUTODIN access circuits disrupted.
- o A dedicated voice Army command and control circuit from Heidelburg to Giessen is disrupted.
- o A dedicated voice Air Force command and control circuit from Ramstein to Berlin is disrupted.

IV. Estimated Time Duration: Thirteen days. Recovery and reconstitution consists of the following actions:

1) Clear debris for installation of mobile assets (3 days)
2) Deploy mobile "Cat A" assets to restore link connectivity (10 days after completion of Step 1)
3) Deploy mobile assets to replace the AUTOVON switch (6 days, concurrent with Step 2)

V. Stress Indicating Parameters

A. AUTOVON Parameters: Several reports specified in ICD-004 indicate the nature of this stress, as described in the following sections.

1. Reports from the Feldberg switch:

R4, R5 Real time traffic parameter reports will not be received on time.

2. Reports from adjacent switches. Each of the network switches which has a trunk group to Feldberg (listed in Section B.1) will issue the following reports about the trunk group to Feldberg:

   R30 Failure of trunk group cluster.

   R31 The transmission group associated with the trunk group will report out of sync.

   R27 The next real time report of the error rate on the transmission group associated with the trunk group will report out of sync.

   R3, R4, R5, R6 All traffic parameters will have indications of no new successful seizures of trunks to Feldberg. The exact nature of these parameter changes is dependent on details of the switch software. In any case, these indications could be confused with an interval of exceptionally light traffic.

3. Reports from throughout the network:
   Traffic parameters throughout the network would have the following changes:

   a. Calls complete to Feldberg drops to zero.

   b. Calls offered to secondary and tertiary routes to Feldberg increase without an attendant blocking rate increase on the configured so that trunk groups correspond to transmission groups. Traffic parameters are slow responding and have ambiguous meaning, so they are not as good as the direct parameters for indicating this type of stress.

A similar technique is used in the transmission system. The telemetry alarms on the Feldberg links reporting to a working ATEC node indicate that a failure of the Feldberg station is likely. The mux alarms on all other circuits to Feldberg confirm that the entire Feldberg station has failed (or is isolated, which has the same effect).

VII. Control Technique

There is no path available to restore either the ULS or the command and control circuit to Giessen, therefore no control can be applied. The three AUTODIN circuits can be patched through to Berlin, and restored via satellite. The Berlin-Ramstein command and control circuit can be restored via satellite.

The most important control for AUTOVON is to restore a transatlantic gateway capability in Germany. There would be a preplanned restoral activity in case of a failure of Feldberg, which would designate another switch as a gateway and change routing tables and IST connectivity as appropriate. Since the submarine cable and COMSAT circuits enter the DCS at Feldberg station, they cannot be rapidly reconfigured. The DSCS transatlantic circuits pass through Donnersberg. Therefore, a quick reaction backup would be to designate Donnersberg as the new gateway. This plan has the advantages of requiring no other connectivity changes since all switches connect to Donnersberg. It has the disadvantage that Donnersberg is already heavily loaded relative to the other network switches. This traffic load may be estimated by summing the originating traffic at all remaining switches in Germany together with all the CONUS originated traffic destined for Germany. This estimate puts the normal busy hour call arrival rate at 1.1 calls/sec, which is well within the capabilities of a TTC-39 switch. It is therefore reasonable to make Donnersberg the new gateway.

VIII. Narrative

Event Time	Description
00:00:00.0	Feldberg station experiences complete failure.
00:00:00.1	All adjacent switches (listed in Section II. B. 1.) issue R30 messages indicating failure of the Feldberg trunk group. These

	reports enter the ATEC system at their respective nodes.
00:00:00.2	Transmission system alarms are detected by the ATEC ARS elements. ATEC fault isoluation begins.
00:00:02	Switch reports arrive at ACOC. Trunk fault correlation algorithm identifies the stress as a node failure at Feldberg, but no alarm is issued because traffic parameter reports are not overdue. The summary display, trunk status display, and trunk fault detail displays for each affected trunk group are updated to reflect the report arrivals.
00:02:00	ATEC fault isolation determines failure of all links to Feldberg whose monitoring stations report to a working node. Link failure messages are sent to ACOC from Stuttgart and Langerkopf sectors.
00:03:00	ATEC fault isolation terminates. ACOC determines that transmission failures have isolated the Feldberg station. Connectivity control is alarmed.

00:03:30	Traffic reports from Feldberg become overdue, completing the AUTOVON fault isolation routine. AUTOVON controller is alarmed that Feldberg has failed. Data base access finds the list of critical circuits interrupted and prepares display for connectivity controller.
00:03:45	AUTOVON controller directs the Donnersberg switch to take over DSCS circuits and become gateway. All routing tables are updated to reflect the new routing.
00:05:00	Local tech controllers at Pirmasens, Landstuhl, Berlin, and Bocksberg initiate preplanned restoral actions to restore the 3 AUTODIN access circuits and the command and control circuit via DSCS. All AUTOVON switches are now operating with new routing.
00:10:00	AUTODIN access and command and control circuits are patched through DSCS.

The repairs necessary in this scenario are so extensive and gradual that return of the system to its nominal capacity is not part of the scenario.

Scenario Nine - AUTOVON Trunk Group Failure

I. Synopsis: The RF link between Donnersberg and Rhein Main, Germany fails due to antenna malfunction. This link was chosen for this scenario because in our deployment model, it interrupts the most heavily loaded intra European AUTOVON trunk group. Therefore the DCS experiences the highest stress level of any single AUTOVON trunk group. The specific failure mode is an example of the type of failure that could cause this stress. Many other failure modes exist which would lead to the same scenario.

II. System Stress

A. Link Connectivity: Backbone link M0372 from Donnersberg to Rhein Main is interrupted. No other links are affected.

B. AUTOVON Subsystem Stress

1. Trunk Connectivity: The trunk group from DON to FEL is interrupted. The trunk group has 30 analog and 10 digital trunks.
2. Route Connectivity: The routes that use the DON-FEL trunk group are shown in Table C-3.
3. User Access Connectivity: The Rhein Main routine users AUTOVON switchboard is isolated from the system. The Rhein Main and Frankfurt ULS's have their access to

TABLE C-3. ROUTES AFFECTED BY LOSS OF DON-RMN RF LINK

NETWORK IMPACT OF TRUNK 15 FAILURE

11 PRIMARY,24 SECONDARY AND,14 TERTIARY ROUTES

PRIMARY ROUTES	SECONDARY ROUTES	TERTIARY ROUTES
CON(1)-SCH(4)	CON(1)-MAM(3)	CON(1)-FEL(5)
CON(1)-DON(6)	CON(1)-DON(6)	CON(1)-DON(6)
CON(1)-LKF(7)	CON(1)-CLO(8)	CON(1)-HUM(10)
SCH(4)-MAM(3)	CON(1)-MRE(9)	HIN(2)-DON(6)
SCH(4)-CLO(8)	MAM(3)-FEL(5)	SCH(4)-DON(6)
SCH(4)-MRE(9)	MAM(3)-DON(6)	DON(6)-HIN(2)
SCH(4)-HUM(10)	SCH(4)-CON(1)	DON(6)-MAM(3)
FEL(5)-DON(6)	SCH(4)-FEL(5)	DON(6)-SCH(4)
DON(6)-CON(1)	SCH(4)-LKF(7)	DON(6)-MRE(9)
DON(6)-FEL(5)	SCH(4)-HUM(10)	DON(6)-HUM(10)
HUM(10)-FEL(5)	FEL(5)-MAM(3)	LKF(7)-DON(6)
	FEL(5)-SCH(4)	LKF(7)-MRE(9)
	FEL(5)-LKF(7)	MRE(9)-DON(6)
	FEL(5)-CLO(8)	MRE(9)-LKF(7)
	FEL(5)-MRE(9)	
	FEL(5)-HUM(10)	
	DON(6)-LKF(7)	
	DON(6)-CLO(8)	
	LKF(7)-FEL(5)	
	CLO(8)-FEL(5)	
	CLO(8)-DON(6)	
	MRE(9)-FEL(5)	
	HUM(10)-FEL(5)	
	HUM(10)-DON(6)	

Donnersberg interrupted, but they still have network access via Feldberg.

4. Traffic Performance: A summary of the busy hour traffic performance in this scenario is shown in Table C-4.

III. Colateral Stress: According to our deployment model, the following system stresses also exist if that link fails:

- Command and control non-common user voice circuits between Ramstein and Berlin, and Ramstein and Rhein Main are interrupted.
- The weather FAX network is interrupted except for Feldberg homed users.

IV. Estimated Time Duration: Six hours. An emergency dispatch from the Antenna Maintenance group at Feldberg brings a team to Rhein Main within one hour. Five hours are required to repair and re-align the antenna.

V. Stress Indicating Parameters

A. AUTOVON Parameters: The TTC-39 switches at Donnersberg and Feldberg would issue several reports via their system control subchannel as specified in ICD-004, relating to the failure of the trunk group.

TABLE C-4. BUSY HOUR TRAFFIC PERFOMRANCE SUMMARY

MEAN GOS=0.1690 VARIANCE OF GOS=0.0616CARRIED TRAFFIC=257.3194

UNWEIGHTED GOS DISTRIBUTION

32	11	7	7	0	0	0	2	0	0
3	0	0	0	0	1	0	2	0	1
0	0	0	0	0	2	0	0	2	0
0	0	0	2	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	1	3	2
0	1	2	0	0	4	1	0	0	1
0	0	1	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

TRAFFIC WEIGHTED GOS DISTRIBUTION

68.10	27.30	8.25	16.50	0.	0.	0.	6.82	0.	0.
3.75	0.	0.	0.	0.	2.10	0.	8.85	0.	0.45
0.	0.	0.	0.	0.	7.95	0.	0.	20.40	0.
0.	0.	0.	21.45	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	19.05	0.	0.	0.	0.	0.	8.10	30.45	37.05
0.	3.30	10.20	0.	0.	65.55	23.55	0.	0.	20.55
0.	0.	1.65	0.	0.	0.	0.	0.	0.	17.55
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	CON	HIL	MAM	SCH	FEL	DON	LKF	CTO	MTV	HUM
CON	0.	0.5887	0.5845	0.5867	0.5958	0.6741	0.6592	0.6292	0.6576	0.5927
HIL	0.5241	0.	0.0000	0.0005	0.0000	0.0170	0.0000	0.0217	0.1070	0.0010
MAM	0.6303	0.0000	0.	0.0011	0.0000	0.1619	0.0000	0.0337	0.0183	0.0004
SCH	0.6156	0.0005	0.0152	0.	0.0016	0.0106	0.0009	0.0399	0.0361	0.0313
FEL	0.6019	0.0000	0.0000	0.0037	0.	0.3382	0.2864	0.1773	0.2606	0.0288
DON	0.7997	0.0170	0.0169	0.0106	0.3382	0.	0.0756	0.0181	0.0010	0.0311
LKF	0.6966	0.0000	0.0000	0.0005	0.2864	0.0103	0.	0.0403	0.0181	0.0003
CTO	0.7286	0.0806	0.0337	0.0272	0.1773	0.0181	0.0403	0.	0.0045	0.0359
MTV	0.6584	0.1070	0.0183	0.0434	0.2606	0.0010	0.0183	0.0045	0.	0.0397
HUM	0.6575	0.0013	0.0011	0.0338	0.1969	0.0032	0.0071	0.0064	0.1126	0.

The following reports would be issued:

R30 Failure of trunk group cluster.

R31 The transmission group associated with the trunk group will report out of sync.

R27 The next real time report of the error rate on the transmission group associated with the trunk group will report out of sync.

R3, R4, R5, R6 All traffic parameters will have indications of no new successful seizures of trunks to Feldberg. The exact nature of these parameter changes is dependent on details of the switch software. In any case, these indications could be confused with an interval of exceptionally light traffic.

Loop continuity tests from Donnersberg to Rhein Main and Frankfurt will show loss of continuity and cause local alarms at DON, but no reports are issued because of the alarms.

B. ATEC Reports: According to our proposed ACOC-ATEC interface, ATEC will report the loss of link M0327 to ACOC as soon as it is fault isolated.

VI. Stress Detection and Isolation: Correlation of the trunk group failure messages from DON and FEL indicate a transmission system failure. The ATEC report of a link failure confirms this. The connectivity control function identifies the weather fax and command and control circuits which also use the link.

VII. Control Technique: The connectivity controller directs patching and preemption at Donnersberg, Feldberg, and Langerkopf to restore the weather fax network and the command and control circuits. No control is applied to the Rhein Main or Frankfurt ULS access lines, because they still have service.

Additional routes from Donnersberg to Feldberg via Schoenfeld and via Martlesham Heath could be activated to absorb some of the heavy Donnersberg-CONUS traffic load. This control is not needed to assure critical subscriber connectivity, but could improve routine GOS somewhat.

VIII. Narrative

Event Time	Description
00:00:00.0	RF link from Donnersberg to Rhein Main fails.
00:00:00.1	Switches at Donnersberg and Feldberg issue

trunk group failure reports.

00:00:02.0	ATEC alarm reports of loss of RSL and multiplex framing alarm at Rhein Main and Donnersberg arrive at Feldberg and Donnersberg nodes respectively.
00:00:03.1	Switch reports arrive at area. Trunk fault correlation algorithm makes a preliminary decision that there is a transmission fault and updates its displays to indicate that.
00:02:00	Langerkopf reports failure of Donnersberg-Rhein Main link to area, confirming the trunk fault correlation algorithm's preliminary decision. AUTOVON controller is alarmed.
00:02:30	Data base access to Donnersberg node reveals the C^2 and weather fax collateral stress, and requests Langerkopf sector to check on the availability of links in the preplanned altroute.

00:03:00	Area determines routing table changes for Donnersberg, Feldberg, Schoenfeld, and Martlesham Heath switches, and issues system control messages to those switches via telemetry.
00:03:30	Donnersberg receives status or preplanned altroute, initiates patching. Donnersberg also sends patch coordination to Langerkopf.
00:03:35	Donnersberg sends patch instruction to Feldberg node via Stuttgart sector.
00:04:00	Donnersberg switch executes loop test to Rhein Main ULS, activating a local alarm at Donnersberg. Since restoral activity has already been completed, alarm is ignored.
00:08:20	Real time traffic reports from Donnersberg and Feldberg indicating stress arrive at area. Since control action is already completed, no further action is taken.
00:10:00	Patching of C^2 and weather fax is completed.
06:00:00	Link restored.
06:00:02	Donnersberg and Feldberg report restoral of trunk group to area.

06:01:00	Donnersberg notifies Langerkopf to return to normal configuration. Langerkopf notifies Feldberg via Stuttgart.
06:01:30	Area broadcasts message to Donnersberg, Feldberg, Schoenfeld, and Martlesham Heath to return to normal routing tables.

Scenario Ten - Partial AUTOVON Trunk Group Failure

I. Synopsis: First level multiplex failures between Donnersberg and Feldberg interrupt 18 of the 30 analog IST's and all the digital IST's between Donnersberg and Feldberg at normal busy hour. This scenario demonstrates the difference between a complete trunk group failure as in Scenario 9 and a partial failure. This scenario as described assumes that the TTC-39 switch does not automatically attempt to use in band signalling when the common channel signalling fails. The TTC-39 hardware would support an automatic attempt to use in band signalling since all switch terminations are monitored by the scanners, and in band signalling receivers are terminated directly on the switch matrix. If the software were modified to provide automatic changeover to in band signalling, several of the detailed reactions of the system would be different from those described here.

II. System Stress

A. Link Connectivity: All links are functioning normally. Multiplexer failures causes the loss of Digroup 7 of the B mission bit stream between Donnersberg and Feldberg.

B. AUTOVON Subsystem Stress

1. IST Connectivity: 18 of the 30 analog IST's and all of the digital IST's between Donnersberg and Feldberg are disrupted.

2. Route Connectivity: The routes impacted by the reduction in DON-FEL connectivity are listed in Table C-5.

TABLE C-5. ROUTES AFFECTED BY FAILURE OF DON-FEL LINK

NETWORK IMPACT OF TRUNK 15 FAILURE

11 PRIMARY,24 SECONDARY AND,14 TERTIARY ROUTES

PRIMARY ROUTES	SECONDARY ROUTES	TERTIARY ROUTES
CON(1)-SCH(4)	CON(1)-MAM(3)	CON(1)-FEL(5)
CON(1)-DON(6)	CON(1)-DON(6)	CON(1)-DON(6)
CON(1)-LKF(7)	CON(1)-CLO(8)	CON(1)-HUM(10)
SCH(4)-MAM(3)	CON(1)-MRE(9)	HIN(2)-DON(6)
SCH(4)-CLO(8)	MAM(3)-FEL(5)	SCH(4)-DON(6)
SCH(4)-MRE(9)	MAM(3)-DON(6)	DON(6)-HIN(2)
SCH(4)-HUM(10)	SCH(4)-CON(1)	DON(6)-MAM(3)
FEL(5)-DON(6)	SCH(4)-FEL(5)	DON(6)-SCH(4)
DON(6)-CON(1)	SCH(4)-LKF(7)	DON(6)-MRE(9)
DON(6)-FEL(5)	SCH(4)-HUM(10)	DON(6)-HUM(10)
HUM(10)-FEL(5)	FEL(5)-MAM(3)	LKF(7)-DON(6)
	FEL(5)-SCH(4)	LKF(7)-MRE(9)
	FEL(5)-LKF(7)	MRE(9)-DON(6)
	FEL(5)-CLO(8)	MRE(9)-LKF(7)
	FEL(5)-MRE(9)	
	FEL(5)-HUM(10)	
	DON(6)-LKF(7)	
	DON(6)-CLO(8)	
	LKF(7)-FEL(5)	
	CLO(8)-FEL(5)	
	CLO(8)-DON(6)	
	MRE(9)-FEL(5)	
	HUM(10)-FEL(5)	
	HUM(10)-DON(6)	

3. User Access Connectivity: No critical user access circuits are impacted by this stress.

4. Traffic Performance: A summary of the network traffic performance in this situation is shown in Table C-6.

III. Colateral Stress: No other subsystems are affected by this stress.

IV. Estimated Time Duration: 1½ hours. Repair is done by replacing a card in the Feldberg first level multiplexor. Normal time for repair of a first level multiplex is 30 minutes, but errors in maintenance procedures cause an extra 1 hour delay.

V. Stress Indicating Parameters

A. AUTOVON Parameters: With the loss of the digital portion of the trunk group and the associated signalling channel, the following reports specified in ICD-004 would be issued by the TTC-39 switches at Feldberg and Donnersberg relative to the trunk group between them:

R30 Failure of trunk group cluster.

R31 The transmission group associated with the trunk group will report out of sync.

R27 The next real time report of the error rate on the transmission group associated with the trunk group will report out of sync.

TABLE C-6. NETWORK TRAFFIC PERFORMANCE SUMMARY

MEAN GOS=0.1560 VARIANCE OF GOS=0.0604CARRIED TRAFFIC=267.1206

UNWEIGHTED GOS DISTRIBUTION

37	9	2	7	1	2	1	0	0	2
4	0	3	0	0	2	2	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	3
2	1	3	1	2	2	0	0	1	0
0	0	1	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

TRAFFIC WEIGHTED GOS DISTRIBUTION

83.10	15.45	2.25	7.35	1.50	17.25	0.08	0.	0.	1.50
13.20	0.	20.85	0.	0.	7.95	21.45	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	19.05	0.	0.	0.	0.	0.	0.	29.25
27.30	19.05	28.05	23.55	25.20	25.80	0.	0.	20.55	0.
0.	0.	17.55	1.65	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	CON	HIL	MAM	SCH	FEL	DON	LKF	CTO	MTV	HUM
CON	0.	0.6045	0.6010	0.6024	0.6075	0.6417	0.6330	0.6275	0.6457	0.6065
HIL	0.5288	0.	0.0000	0.0001	0.0000	0.0105	0.0000	0.0235	0.0964	0.0003
MAM	0.6473	0.0000	0.	0.0010	0.0000	0.1141	0.0000	0.0379	0.0208	0.0001
SCH	0.6324	0.0001	0.0096	0.	0.0009	0.0051	0.0002	0.0389	0.0265	0.0346
FEL	0.6155	0.0000	0.0000	0.0024	0.	0.1671	0.1338	0.1103	0.1594	0.0117
DON	0.7322	0.0105	0.0102	0.0051	0.1671	0.	0.0571	0.0237	0.0021	0.0367
LKF	0.6904	0.0000	0.0000	0.0001	0.1338	0.0057	0.	0.0398	0.0182	0.0001
CTO	0.7423	0.0730	0.0379	0.0231	0.1103	0.0237	0.0398	0.	0.0043	0.0511
MTV	0.6633	0.0964	0.0208	0.0392	0.1594	0.0021	0.0192	0.0043	0.	0.0579
HUM	0.6582	0.0004	0.0003	0.0242	0.1282	0.0038	0.0071	0.0087	0.1105	0.

R3, R4, R5, R6 All traffic parameters will have indications of no new successful seizures of trunks to Feldberg. The exact nature of these parameter changes is dependent on details of the switch software. In any case, these indications could be confused with an interval of exceptionally light traffic.

If the signalling channel had not been lost, these reports would not be issued and the group would continue in service. Initially, the switch would establish connections over failed trunks since there is no pre cut-through circuit testing. When secure calls are connected in this manner or the switch routines the trunk (which will happen within a minute or two) the trunk will be marked out of service. When all of the failed trunks are marked out of service, the ratio of blockages to call attempts will increase without an increase in call attempts, as reported in R4 and R5 real time traffic reports. Preemptions, reported in R6, could either increase or decrease dependent on the state of traffic on the trunk before the failure. If the traffic were initially light and the remaining operating trunks were not sufficient to handle the traffic, preemptions would increase. If the traffic were initially heavy, preemptions could decrease because the group would be full of high priority calls and new originating traffic would not have sufficient precedence to exercise preemption. Finally, if the remaining capacity were sufficient to handle the traffic, preemptions would be unchanged at a very low random number.

B. ATEC Reports: According to our proposed system control structure, ATEC will report that the digroup has lost frame sync.

VI. Stress Detection and Isolation: In this case, where the signalling channel is interrupted, the indications given by the report parameters are that the entire group has failed. The transmission system indications are that only part of the group has failed. Since the partial failure could account for the messages received, the AUTOVON failure correlation algorithm could determine that the failure was a partial group failure including signalling channel.

VII. Control Technique: The appropriate control technique for this scenario is to reconfigure the failed trunk group so that the portion still operating is usable. If manual tech control techniques are being used, this would consist of separating the analog and digital common signalling channels and patching the analog signalling modem to a working channel. If automatic tech control procedures are available, the appropriate control technique would be to replace the working analog trunks with a digital trunk group. This would maintain the secure capability of the trunk group and provide two to four times the number of channels.

VIII. Narrative

Event Time

00:00:00.0 Digroup 7 of the DON-RMN-FEL B mission bit stream fails, causing the loss of 18 of 30 analog and all 10 digital trunks between DON and FEL.

00:00:00.1 AUTOVON switches at FEL and DON issue R30 trunk group failure messages. These messages enter the ATEC system at their respective nodes.

00:00:00.2 ATEC ARS elements at FEL and DON detect multiplex loss of frame alarms on Digroup 7-B.

00:00:01.8 Switch reports arrive at ACOC. Trunk fault correlation algorithm tentatively identifies fault as a trunk group failure, seeks transmission system confirmation. Summary display, trunk status display, and trunk fault detail display are updated to reflect the message arrivals and preliminary fault identification.

00:02:03 ATEC fault isolation terminates without identifying the cause of the fault. The loss of frame alarms, still present, is reported to ACOC.

00:02:40 Connectivity control function determines that the loss of frame alarms corresponds to part of the recently failed AUTOVON trunk group, but that part of the group is not affected.

00:02:41	AUTOVON fault correlation algorithm determines that the trunk group failure alarm would be caused by the confirmed circuit failure, but that a portion of the group is still usable. A trunk group modification directive D10 is issued to FEL and DON switches directing them to reconfigure the remaining trunks into a usable trunk group.
00:05:23	Switch supervisors at DON and FEL complete the trunk group reconfiguration and place the group on line. R30 messages from DON and FEL, indicating the new trunk group on line, are sent to ACOC.
00:10:00	FEL and CON maintenance determine that the multiplexer at FEL is the problem based on local alarms at both ends.
00:11:30	BITE functions executed in the FEL multiplex indicate a faulty circuit card.
01:25:00	A proper replacement card is located and installed, restoring the multiplex to service.
01:30:00	Testing verifies that Digroup 7-B is now operating properly. A restoral of service message is sent to ACOC.
01:32:30	AUTOVON control is notified that its circuits have been repaired.

01:33:00	AUTOVON control sends trunk group modification directives to DON and FEL directing them to return to the normal configuration.
01:34:00	Switch supervisors add the trunks from Digroup 7-B to the operating trunk group.
01:34:30	Switch supervisors cut over from separated signalling to unified signalling.
01:35:30	Switch supervisors pull the patches for the temporary analog signalling channel.

Scenario Sixteen - General AUTOVON Traffic Overload

I. Synopsis: The AUTOVON network in Europe experiences a buildup of traffic due to military operations. The traffic builds uniformly to a level of 250% of normal peak busy hour. All elements of the DCS - links, switches, etc., are operating properly.

II. System Stress: The only system stress is the AUTOVON traffic level. At 250% of normal busy hour, the traffic performance is as summarized in Table C-7.

III. Colateral Stress: None.

IV. Estimated Time Duration: Two hours. During the first hour, command and control driven communication requirements cause increasing traffic. After an hour, execution of military activity begins and communications requirements drop back toward normal.

V. Stress Indicating Parameters

A. AUTOVON Parameters: All measurements of traffic parameters will show increasing traffic. As shown in the parameter selection section, the best parameter for detecting traffic overloads is the number of attempts/trunk group. This parameter is contained in Report R5 as specified in ICD-004.

B. ATEC Reports: There are no system faults, so ATEC will not make any reports relative to this stress.

TABLE C-7. TRAFFIC PERFORMANCE SUMMARY AT 250% PEAK BUSY HOUR

MEAN GOS=0.4941 VARIANCE OF GOS=0.0633CARRIED TRAFFIC=347.5687

UNWEIGHTED GOS DISTRIBUTION

0	0	0	0	2	4	0	0	0	0
0	2	0	0	0	0	2	0	0	0
0	0	0	0	1	4	1	3	3	1
2	1	0	2	1	1	1	1	4	3
1	1	0	1	1	2	3	0	0	0
4	0	0	0	2	1	5	3	2	0
1	0	0	2	0	2	0	1	0	1
0	0	0	0	0	0	0	0	0	0
0	0	1	3	1	1	0	1	2	2
1	2	2	1	1	0	0	0	0	0

TRAFFIC WEIGHTED GOS DISTRIBUTION

0.	0.	0.	0.	0.56	8.63	0.	0.	0.	0.
0.	15.00	0.	0.	0.	0.	15.75	0.	0.	0.
0.	0.	0.	0.	21.00	13.13	7.13	28.13	14.81	1.88
4.50	7.13	0.	5.44	0.75	19.13	13.13	4.88	24.38	15.38
1.50	5.25	0.	7.88	16.88	3.75	17.63	0.	0.	0.
70.88	0.	0.	0.	0.38	26.25	79.13	6.00	7.13	0.
1.13	0.	0.	3.75	0.	8.63	0.	1.50	0.	1.50
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	47.63	110.25	47.63	19.88	0.	56.25	31.13	102.00
51.38	44.25	52.13	25.88	4.13	0.	0.	0.	0.	0.

	CON	HIL	MAM	SCH	FEL	DON	LKF	CTO	MTV	HUM
CON	0.	0.8372	0.8424	0.8912	0.8360	0.9004	0.8849	0.9166	0.8963	0.8911
HIL	0.8343	0.	0.1655	0.2646	0.0497	0.2588	0.0611	0.5844	0.4608	0.3031
MAM	0.8597	0.1655	0.	0.4075	0.0559	0.4207	0.1191	0.5506	0.3524	0.3389
SCH	0.9335	0.2646	0.3991	0.	0.3747	0.3961	0.2771	0.6971	0.6123	0.5858
FEL	0.8471	0.0497	0.0559	0.3950	0.	0.5674	0.5135	0.5739	0.5140	0.3917
DON	0.9286	0.2588	0.2506	0.3961	0.5674	0.	0.4519	0.4653	0.2782	0.4423
LKF	0.9090	0.0611	0.1191	0.2694	0.5135	0.3632	0.	0.6628	0.3857	0.2899
CTO	0.9476	0.5765	0.5506	0.6818	0.5739	0.4653	0.6628	0.	0.2943	0.6406
MTV	0.9179	0.4608	0.3398	0.6403	0.5140	0.2782	0.3893	0.2943	0.	0.5553
HUM	0.9437	0.3101	0.3832	0.5947	0.4692	0.3087	0.3184	0.5701	0.5814	0.

VI. Stress Detection and Isolation: Monitoring and thresholding call attempts per trunk will indicate which trunk groups are overloaded. In this case, all trunk groups are overloaded.

VII. Control Actions: No control actions are needed to provide critical subscriber connectivity. The normal precedence system assures that connectivity. Slightly better grade of service can be provided to routine users by restricting traffic to primary routing only. The traffic performance under primary routing only is summarized in Table C-8. Primary routing only rules should be applied only to lower priority users. Under primary routing only, a single network failure can destroy connectivity between several source-destination node pairs. The control is therefore not applicable to critical subscribers.

VIII. Narrative

Event Time	Decription
00:00:00	Network is at normal peak busy load.
00:30:00	Military operations commence with command and control notifications. This raises the traffic level to 115%.
00:45:00	Full administrative and command and control operations drive the network to 150% loading. Several trunk groups pass their overload threshold,

TABLE C-8. TRAFFIC PERFORMANCE SUMMARY - PRIMARY ROUTING ONLY

MEAN GOS=0.4690 VARIANCE OF GOS=0.0838CARRIED TRAFFIC=378.1576

UNWEIGHTED GOS DISTRIBUTION

8	0	0	0	0	2	4	0	2	0
0	0	0	0	0	0	4	0	0	2
2	0	0	0	2	0	0	4	0	0
0	0	2	0	0	0	2	0	0	0
0	2	1	0	2	0	7	0	0	0
0	2	0	4	2	0	2	2	0	3
0	0	0	1	1	4	0	0	0	0
2	0	2	0	0	1	0	0	2	0
0	0	0	4	3	0	0	2	0	4
0	0	2	0	0	1	0	0	0	0

TRAFFIC WEIGHTED GOS DISTRIBUTION

24.94	0.	0.	0.	0.	3.38	29.63	0.	12.00	0.
0.	0.	0.	0.	0.	0.	15.75	0.	0.	19.88
36.00	0.	0.	0.	8.81	0.	0.	28.88	0.	0.
0.	0.	16.50	0.	0.	0.	14.63	0.	0.	0.
0.	1.13	7.13	0.	51.00	0.	28.31	0.	0.	0.
0.	53.63	0.	54.00	7.13	0.	26.25	3.00	0.	2.25
0.	0.	0.	3.75	1.13	22.13	0.	0.	0.	0.
0.38	0.	2.25	0.	0.	6.00	0.	0.	92.63	0.
0.	0.	0.	132.75	42.00	0.	0.	107.63	0.	184.50
0.	0.	9.75	0.	0.	23.25	0.	0.	0.	0.

	CON	HIL	MAM	SCH	FEL	DON	LKF	CTO	MTV	HUM
CON	0.	0.8369	0.8384	0.8468	0.7883	0.8976	0.8845	0.9272	0.9024	0.9555
HIL	0.8369	0.	0.0094	0.1676	0.	0.0857	0.	0.4728	0.4693	0.0615
MAM	0.8384	0.0094	0.	0.7291	0.	0.5687	0.6590	0.7125	0.6003	0.0703
SCH	0.8468	0.1676	0.7291	0.	0.2762	0.3718	0.1676	0.5812	0.4178	0.5486
FEL	0.7883	0.	0.	0.2762	0.	0.5162	0.4542	0.5375	0.2026	0.6362
DON	0.8976	0.0857	0.5687	0.3718	0.5162	0.	0.2092	0.3334	0.0733	0.2815
LKF	0.8845	0.	0.6590	0.1676	0.4542	0.2092	0.	0.4728	0.4693	0.7579
CTO	0.9272	0.6045	0.7125	0.5812	0.5375	0.3334	0.4728	0.	0.2548	0.6600
MTV	0.9024	0.4693	0.6003	0.4178	0.2026	0.0733	0.4693	0.2548	0.	0.5438
HUM	0.8469	0.0615	0.0703	0.5486	0.6524	0.2815	0.4318	0.6600	0.5438	0.

	causing a traffic alarm at the AUTOVON controller's position.
00:46:00	AUTOVON controller directs all switches to go to primary routing only for traffic below FLASH precedence. This is mechanized via a text message to the switch supervisors.
01:00:00	Pyramiding of communications requirements subsequent to command and control operations push the network load to 250% of normal peak busy hour.
01:30:00	Increased military operations are in full execution. Communications requirements begin to return to normal. Network load is now 175% of peak busy hour.
01:45:00	Communications requirements are down to 120% of peak busy hour. AUTOVON controller directs a return to full alternate routing capability via a text message.
02:00:00	Network returns to normal. Traffic load is below normal busy hour and will remain there.